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VOL. III.

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DEPARTMENT OF MINES, SYDNEY.

RECORDS

OF THE

GEOLOGICAL SURVEY OF NEW SOUTH WALES.

Vol. III.] 1892. [Part 1.

I.—Description of the Belubula Caves, Parish of Malongulli, Co. Bathurst*: By the late C. S. Wilkinson, L.S., &c., Government Geologist.

[Plates I–III.]

The Belubula Caves are on the purchased land of the old "Belubula Copper Mining Company," and are situated two miles north of the main road from Carcoar to Canowindra, eighteen miles from Carcoar, and about the same distance in a north-easterly direction from Cowra, Parish of Malongulli, Co. Bathurst.

The locality is one of much interest. High hills, with declivitous rocky spurs, descend on either side of a picturesque valley to a clear running creek, which flows with a tortuous course for about two miles, and then joins the Liscompool Creek. Some of the hills are composed of a dark porphyritic rock, an igneous rock, which, in the Devonian Period, upheaved and tilted those thick strata of limestone, whose grey rugged masses, out-cropping at the surface, form such an attractive feature in the landscape. The effect of atmospheric influences on exposed limestone rocks is here beautifully shown. The pinnacled crests and grooved surfaces of these rocks reveal in unmistakeable characters the furrowing action of rain during the present and a past age. It is amongst these strangely weathered rocks, on the side of one of the limestone spurs, not far from the creek, that the three newly-discovered caves occur.

* Extracted from the Sydney *Town and Country Journal*, Sept. 9, 1876, p. 419.

Two of the persons who found these caves accompanied me, and directed my attention first to the "Deep Cave." This consists of an almost vertical pit, the opening of which is only about three by six feet. We descended by means of a rope for forty feet, on to a ledge of rock; from this we saw that the chasm opened out to twenty feet in width and fifty feet in length, and continued to a considerable depth, as indicated by the stones which we rolled into it, but having come to the end of our rope we could not descend further. We also saw a large cavernous opening towards the south-west, leading off probably to another long, vertical pit of unknown depth, the mouth of which occurs about one hundred yards higher up the hills; into this we could not enter with the means at our disposal.

We next proceeded for about two hundred and seventy-five yards in a south-easterly direction to the "Bone Cave," the entrance to which faces towards the east, and is twenty feet wide and six feet high, but it appears originally to have been much larger. Immediately within the entrance the cave is almost blocked up with masses of rock fallen from the roof; but, by crawling over and squeezing between them, we descended about twenty-five feet, and came to a large vertical hole fifteen feet deep, hung round with ornamental stalactites; in places the sides were formed of red calcareous earth, from which numerous bones protruded (Pl. III). From the bottom of this hole we passed for six feet between walls covered with stalactites, and entered a cavern fifteen feet by twenty-four feet and ten feet high. From its roof hung beautiful stalactites, some round and pointed, and others in wavy folds like white curtains with serrated edges. Part of the floor is formed of four separate layers of stalagmite, underneath which is red earth full of fragments of bones, mingled together in a confused state. I had a large quantity of these bones collected, some of which were embedded in the hard crystalline stalagmite. On the east side is an opening nearly choked up by stalactites and red earth; it is too small to enter, but we could send stones rolling down it for a considerable distance. Not being able to go any further in this cave, we climbed up, and scrambled over the piles of rock *débris*, and returned to daylight, and proceeded to explore the "Long Cave," the mouth of which is forty-four yards south from the Bone Cave (Pl. I). Descending a perpendicular hole for six feet between craggy masses of limestone rock, we entered a passage and walked along it till we suddenly came to a small opening, which we crawled through on all-fours into a room fifteen feet wide and eight feet high. But to pass from this we had to resort to more primitive means of locomotion, by squeezing into a hole only thirteen inches high and two feet wide, and sliding down it for six feet on one's back, or on whichever side was best proof to the probing stalactites, contact with which was not always agreeable. At the foot of this incline is a thin layer of stalagmite, and through a hole broken in it we got down, and again on all-fours crawled beneath it for thirty-six feet, and then entered a long

cavern thirty-five feet high. The wall of it on the north side rises with an irregular sloping surface to the roof, and is, as it were, covered with white tracery. From the roof hang numerous stalactites, and there is one of them very fine, being upwards of six feet in diameter and eighteen feet long; it is deeply fluted and resembles the pipes in front of a large organ. From projecting ledges around the walls hang beautiful white stalactites of various lengths. They suggest the idea of petrified cascades, which in reality they are.

At the northern end this cavern branches off into two—one extending to the north-west for sixty feet, and it evidently continued further, but is now filled up with red earth full of fragments of bones; the other forms a high passage one hundred feet long, leading into a lofty and spacious chamber seventy feet in width. Here are to be seen two remarkable stalagmites eighteen inches in diameter and six feet high, they are pointed at the apex and conjoined at the base, and stand on a conical mound of stalagmite (Pl. II.) Immediately over them, and on one side, hang some beautiful curtain stalactites, descending from the roof in drapery-like folds, gracefully disposed.

When well lighted up the contrast of these white stalactites against the dark, sombre, grey limestone walls presents a very striking and weird appearance. A huge fissure extends across the roof, and probably communicated overhead with two open caverns in the surface of the hill. Out of these a strong draught of air issues, and they are doubtless the cause of the good ventilation of the main parts of the "Long Cave." From the large cavern there are seven passages branching off in various directions, and leading into other smaller chambers. In nearly all of these fresh objects of interest and attraction are exhibited. The small "Fountain Chamber" has a white floor with ornamental cavities filled with clear water from which has been formed those calcite crystals which sparkle on the sides of the cavities. In some of the caves where they have been filled with this lime water, the walls are coated with these crystals. Another small cavern, rather difficult to get into, has a mound of white stalagmite with a tracery-marked surface, meeting which, and hanging in the centre are two stalactites covered with translucent spikes curving in all directions. These singular stalactites are seen in some of the other caverns; also groups of long radiating crystals of arragonite.

We could not explore to the end of some of the passages, owing to the foul air met with, which, if we had inhaled it, would have extinguished our lives, as it immediately did our candles.

In almost all of the caverns there are two, sometimes more, layers of stalagmite both above and below which the red earth and fossil bones are found. The caves appear to have been once filled with this bone earth, which is of such a nature as

to show that it has been drifted into the caves by water, and then partly washed away again to some lower level, probably down to some of those deeper passages into which we could not enter on account of the foul air in them.

It is possible there may have been other entrances to these caves, but which are now filled up by rock *débris*, certain depressions in the surface of the hill may indicate where they existed.

The origin of these caverns is apparent. Natural joint-fissures in the limestone beds received the surface-water, which, with the aid of the carbonic acid gas contained in it, dissolved the limestone rock and in process of time these subterraneous water-courses gradually became enlarged to their present dimensions. But this took place at a period when the configuration of the surface of the land was different from what it now is. The very hills where the entrances to the caves now are, were once the bottom of valleys.

At that time the present valleys were not scooped out of the land surface, and these caverns then received the drainage. So that where is now the top of a hill a valley existed, and hills then stood where valleys now lie. But owing to the variable nature of the geological formations, the harder rocks resisted the denuding atmospheric influences, while hills of rock more readily disintegrated, had to yield to the gouging hand of time, and thus the land surface was ever changing till its present features were formed.

The miniature hills and valleys seen on those grooved, weathered, limestone rocks, before mentioned, well serve to illustrate these effects of denudation.

During these changes the original entrances to the cave have doubtless been removed, and in this way may have disappeared those places of resort which were frequented by some of the animals, whose bones were drifted into their present sepulchre.

But little surface-water can now enter these caves,—the *débris* of stones, earth and bones, appears to have been drifted in, chiefly during the Pleistocene Period.

Mr. E. Ramsay, F.L.S., Curator of the Australian Museum, has identified some of the bones as belonging to the genera *Macropus* (large Kangaroo), *Phascolomys* (Wombat), *Halmaturus* (Wallaby), and *Protemnodon*, an allied extinct genus. Several other bones may prove to be of new species.

The Belubula Caves were first explored by Messrs. T. J. Peters, T. and J. O'Shaughnessy, and A. Potts, road contractors.

I saw several depressions and holes in the limestone rocks in the vicinity, which probably lead into other subterranean chambers.

About half-a-mile in an easterly direction from the caves is the shaft of the Belubula Copper Mining Company. It has been sunk following a breccia-quartz reef, two feet thick; the quartz contains the grey sulphide and carbonates of copper sparingly distributed through it, also calcite. The reef traverses porphyritic diorite and dips S. 20° W. at 62°. It is probably auriferous.

Near the Belubula River on Mr. W. M. Rothery's Estate, and about three miles north from the Caves, there is a hot spring, from which, Mr. Rothery informed me, that a volume of water at a temperature of 88° Fahr. issues at the rate of about seven hundred gallons per minute. That it contains lime in solution is evident from the calcareous tufa deposited from it. This spring is said to have been running in the same manner ever since it was discovered, more than thirty years ago. It is, no doubt, an outlet for the water collected by some of the numerous caves in this limestone country, the water becoming heated in its passage through the rocks at considerable depths.

II.—*Hymenocaris Salteri*, M'Coy, m.s. : by R. ETHERIDGE, Junr., Palæontologist and Librarian.

[Plate IV.]

I.—History.

As early as 1861, Sir F. M'Coy determined a Crustacean from the Graptolite Shales of Victoria as *Hymenocaris Salteri*,* but no description was offered, the Professor contenting himself with the following remark—"The characteristic genus *Hymenocaris* of these ancient beds in Wales also occurs here in a peculiar species, *H. Salteri* (M'Coy)."

The name has appeared in print at intervals since then, but after a lapse of thirty years, I believe, it still remains a M.S. name. The second occasion on which Professor M'Coy referred to his fossil appears to have been in the Second Edition of his "Ancient and Recent Natural History of Victoria,"† and a third time in a list of Victorian fossils contributed to the "First Annual Report" of the Second Geological Survey of Victoria,‡ by the late R. Brough Smyth. By Bigsby, the species was twice catalogued in his laborious compilation "Thesaurus Siluricus,"

* The Ancient and Recent Natural History of Victoria. *Vict. Intercol. Exhib. Essays*, 1861, p. 162.
† Ann. Mag. Nat. Hist., 1867, XX, p. 201.
‡ P. 33 (r. 8vo. Melbourne, 1874).

as *Hymenocaris* and *Caryocaris*.* The latter name was, doubtless, derived from Mr. J. W. Salter, who, during the progress of the London International Exhibition of 1862, had an opportunity of examining authenticated specimens. After noticing the Victorian Llandeilo Graptolites, the latter remarked, "There is even a Crustacean, apparently of the genus *Caryocaris*, which M'Coy has done me the favour to name *Hymenocaris Salteri*.†

In reviewing this species, the British Association Committee "On the Fossil Phyllopoda of the Palæozoic Rocks" (Messrs. R. Etheridge, H. Woodward, and T. Rupert Jones) remark,‡ "The Australian *Hymenocaris Salteri*, M'Coy, having been assigned by Mr. Salter to *Caryocaris*, when he was studying that group in 1862, we have regarded it as a member of the latter genus." They further say—"Thus it is evident that Salter saw one example, if not more, of this Australian species in 1862, and did not regard it as a *Hymenocaris*." This appears to be the concensus of opinion regarding *H. Salteri* up to 1883.§

The object of the present remarks is to show that the fossil is neither a *Hymenocaris*, nor a *Caryocaris*, but is, in all probability referable to another genus of Salter's—*Lingulocaris*. I do not think the Australian Crustacean is allied to *Saccocaris*, judging by the figures given by the Committee.‖

II.—Descriptive Remarks.

Hymenocaris Salteri has never been met with, so far as I know, in any other than a filmy compressed state, quite similar to that of many *Ceratiocaris* in the Upper Silurian rocks of Britain.

Mr. W. W. Froggatt, whilst in charge of the Departmental Exhibits at the Ballaarat Juvenile Exhibition, made a collection of Graptolites from the Lower Silurian shales at Sandhurst, with a number of the filmy compressed carapaces of *H. Salteri*, and fragments of chitinous body segments. I am also indebted to Mr. R. A. F. Murray, Government Geologist of Victoria, for additional specimens from Baynton's, Campaspe River, Central Victoria.

The genus *Hymenocaris* was described by the late Mr. J. W. Salter, in 1852, as having an ample, semi-oval, very thin carapace, curved downwards at the sides, but not angularly bent along the middle line, two pairs of antennæ, and an abdomen of eight or nine segments.¶ Some years later, *Caryocaris* was described ** from the Skiddaw Slates, possessing a long, pod-shaped, bivalve carapace, with distinct hinge pits, rounded in front and sub-truncate behind, whilst the surface is smooth

* Pp. 73 and 200 (4to. London, 1868).
† Quart. Journ. Geol. Soc., 1863, XIX, p. 139, *note*.
‡ Brit. Assoc. Report for 1883 [1884], p. 215.
§ *Loc. cit.*, p. 221.
‖ *Loc. cit.* for 1890 [1891], p. 427.
¶ Brit. Assoc. Report for 1852 [1853], Part 2, p. 58.
** Quart. Journ. Geol. Soc., 1863, XIX, p. 139.

or only wrinkled. It will thus be apparent that *Caryocaris* differs from *Hymenocaris* in its angularly bent, pod-shaped, and thus definitely bivalve carapace, and not a merely arched semi-oval shield curved downwards at the sides.

Now, it will be obvious at the first glance, that in M'Coy's Victorian species the carapace is not ample and semi-oval; furthermore, in all our specimens, the dorsal edge, which is much less curved than the ventral, is always apparent as a distinct hard margin, or sharp impressed line. From these I opine that the carapace was bivalved and sharply bent rather than merely folded. As regards the ends, so far as the filmy nature of the substance will permit one to judge, one, presumedly the posterior, is truncate more or less; the other, equally supposed to be the anterior, is very obtusely pointed. Lastly, the more highly curved of the two margins, which I have assumed to be the lower, invariably shows a double line, one usually within the other, implying that they are the adpressed edges of the two valves. Accepting these facts, there appears to be presumptive evidence that the Victorian Crustacean is not *Hymenocaris*, and the outline of the carapace equally forbids a reference to *Caryocaris*, as suggested by Mr. Salter.

In 1866, Salter proposed a third genus of similar Phyllocardia, under the name of *Lingulocaris*,* with a thin bivalve shell, a generic form like that of a *Modiola*, or *Mytilus*, and the surface covered with fine raised concentric lines. The rather indefinite diagnosis assigned by Salter to his genus, has been supplemented with additional details and figures by the Fossil Phyllopoda Committee, from which it becomes apparent that the Victorian fossil is much more closely allied to *Lingulocaris* than to either of the others. The Committee figure two additional species *L. Salteriana*, and *L. siliquiformis*, with an acutely subovate or sharply boat-shaped carapace. The dorsal margin, or back, is straight, and the ventral, or front, convex. The outline of M'Coy's *Hymenocaris Salteri* is so obviously intermediate between that of these two species, and the typical characters of *Hymenocaris* and *Caryocaris* absent, that a reference of the species to *Lingulocaris* becomes necessary. As the Committee have used Mr. Salter's name in a specific sense, I am reluctantly compelled to abandon M'Coy's term, and cannot, therefore do better than adopt for the fossil in question that of *Lingulocaris M'Coyi* with the following diagnosis:—

Lingulocaris M'Coyi, *sp. nov.*

Pl. IV.

Hymenocaris Salteri, M'Coy (m.s.)—Ancient and Recent Nat. Hist. Vict. (Vict. Intercol. Exhib. Essays), 1861, p. 162.

Hymenocaris Salteri, M'Coy (m.s.)—Ann. Mag. Nat. Hist., 1867, XX, p. 201.

Hymenocaris Salteri, M'Coy (m.s.)—Smyth's 1st Ann. Report, 2nd Geol. Survey Vict., 1874, p. 33.

Caryocaris Salteri, Salter, Quart. Journ. Geol. Soc., 1863, XIX, p. 139, *note*.

Hymenocaris? (Caryocaris) Salteri, Etheridge, Woodward, and Jones, Brit. Assoc. Report for 1883 [1884], Pl. I., p. 221.

* Mem. Geol. Survey Gt. Brit., 1866, III, p. 294.

Sp. Char.—Carapace siliquiform to boat-shaped; anterior end pointed; posterior end subtruncate and slightly oblique; dorsal margin to all intents and purposes straight, but probably very slightly curved; front or ventral margin freely curved, more shapely so towards the anterior end, usually with a double edge, denoting the imperfect apposition of the two valves of the carapace; sculpture consisting of a transverse wrinkling, the test being probably papyraceous.

III.—Notes on the Geology, and Mining in the Trunkey and Tuena Districts: by G. A. STONIER, F.G.S., Geological Surveyor.

I.— General Physical Features.

THE observations refer only to such portions of the districts which the Author was enabled to inspect while dealing with specific instructions.

The district of Trunkey is within the Eastern Division of the Colony, but on the western fall of the Main Dividing Range. The township itself is 2,700 ft. above sea-level, and is generally approached from Newbridge, a station on the Western Railway Line. The country between these two settlements is very much of the same character, being, as a rule, undulating, without any steeply-inclined hills; but from Trunkey, in a southerly direction towards Tuena, the change is very marked, the creeks becoming confined between precipitous sides, and the hills rising in a short horizontal distance to a height of five hundred and six hundred feet above the water-courses.

The main drainage channel of the two districts is the Abercrombie River, which, although sinuous on a small scale, has a fairly direct westerly bearing. It is a rapid stream, and having a watershed of eleven hundred square miles, a small fall of rain will cause a flood, and on this account the working of the alluvial deposits below the present water-level has been attended with difficulties. Below the Rocky Bridge Creek the Abercrombie joins the Lachlan, the chief tributary of the Murrumbidgee River.

The Abercrombie receives various tributaries, such as the Copperhannia Creek, Grove Creek, Tuena Creek, &c., all of which are rapid streams with rough rocky beds and steeply-inclined sides.

Most of the land is utilised for grazing purposes only, the parts suitable for cultivation being of small area, and they have been neglected on account of the generally rough and mountainous character of the surrounding country. On some of the flats a little tobacco is grown by Chinese.

The timber consists principally of white and yellow box, apple-tree, stringybark, peppermint, &c.

II.—*Geological Features, with special reference to Mining.*

The formations developed may be classified as follows:—

1. Recent Alluvium 2. Pleistocene 3. Basalt 4. Eocene	Cainozoic.
5. Granite.	
6. Diorite.	
7. Slates, sandstones, &c., with limestone, gneissoid rocks.	Upper Silurian.

1. RECENT ALLUVIUM.

These deposits are due to the action of the streams of the present day, and are being added to hourly. They consist of sands, clays, &c., with the more or less rounded blocks generally found in watercourses. As the latter are chiefly confined, the alluvials are found in bends of the rivers and creeks on one side or the other, and only at the heads of the streams do they assume the form developed by sluggish streams flowing through flat country. For this reason there are no extensive flats, and the various deposits which do occur are isolated. They are all more or less auriferous, and a large quantity of gold has been won, not only from the river, but also from the Copperhannia Creek, with its tributaries, Tuena Creek, &c.

The Copperhannia Creek has a large watershed, and above its junction with the Abercrombie is known by that name only as far as the Mountain Run Creek, when it passes under the name of Trunkey Creek till the Crooked-tree Creek joins it, and from there to its source it is called Mulgunnia Creek.

Each of the creeks has proved rich, and has been worked in the same manner as most of our alluvial leads, viz.:—First, by Europeans, who have mined the deposits with as much economy of time as possible, and of labour in particular; secondly, by Chinese, who are satisfied with a very much smaller return for their exertions; and in some cases, thirdly, by sluicing-parties. But that the three operations have not extracted the whole of the gold is evinced by the fact that at the present time various parties are making a living on ground previously abandoned as exhausted. It is, however, often difficult to bring a head of water, sufficient for sluicing purposes, on to a particular block of ground, and as the value of a claim depends

upon the ease with which it can be managed, speculators will not start operations without a definite expectation of success. A good deal of money has been expended in cutting races, making dams, &c., and doubtless advantage will be taken of these in the future for working some of the old points.

The Abercrombie itself has been rich, and gold won from it continuously for years. In many places the slates strike directly across the flow of the water, and have acted as natural ripples behind which the gold has accumulated. Most of the deposits worked have been of limited extent, and those still untouched present difficulties which are not readily overcome. In various places in the bed of the river there have been proved to be old waterholes which have become filled with auriferous drift. The mining of these is more difficult than the ordinary alluvial deposit, as the river must be temporarily diverted, and it is only during summer-time that work of the kind can be attempted. Then the old waterhole itself will be "wet," and means may have to be adopted either to pump out the water, or drain it by cutting through the bars of slate which cross the river and form the lower edge of the waterhole. There are doubtless several deposits of this kind which will well repay skilled attention.

The Copperhannia Creek has been worked and abandoned. The few Chinese settled along its banks divide their attention between tobacco-growing and "fossicking."

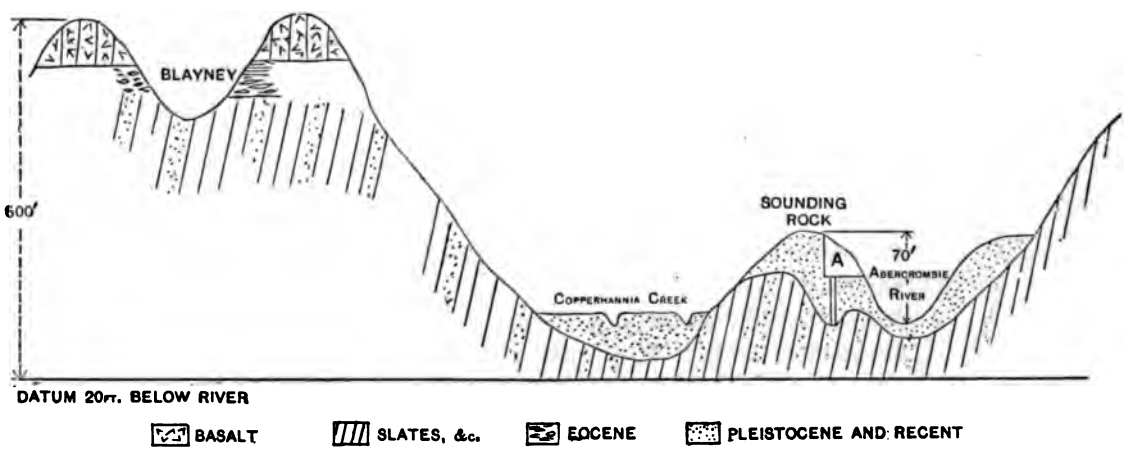
The Mountain Run and Crooked-tree Creeks are of special interest as examples of two distinct sources from which shallow placer deposits derive their gold. The former has a patch of Pleistocene drift, locally known as "the reef," running north and south, and the various gullies which break from it and bear easterly have been particularly rich, and this is not to be wondered at, as they are, in reality, the concentrates of the larger deposits. The latter (Crooked-tree Creek) runs past the township of Trunkey, and several nuggets, as well as fine gold, are reported to have been found at the southern end of the township. The creek cuts across an auriferous belt of country at a slight angle, and the gold has been derived from the wearing away of the veins occurring in the belt, particularly those on the eastern slope, the denuded material being subsequently transported and concentrated in the watercourse below. On the western slope some surfacing has been done, the presence of gold evidently being due to the disintegration of the rocks *in situ*. Surprise has been expressed that no payable vein has been discovered in the immediate vicinity of the surfacing, but it must be remembered that the gold results from the concentration of perhaps hundreds of feet of veinstone, and instances are not wanting in the Colony where the soil capping a reef will give a good prospect for every dish tried, while the reef itself contains only traces of the noble metal.

Tuena Creek has yielded a large amount of gold, and has been payable for a long distance. Few reefs have been discovered along its course. The Costigan Lode, unlike the Great Comstock Silver Lode, does not carry gold, so that it has not assisted in the enriching of the alluvial deposits.

2. PLEISTOCENE.

The deposits referred to under this heading occur, as a rule, at a higher level beyond the reach of existing floods, but it is difficult, and often impossible, to distinguish them from the preceding, for their mode of occurrence points to the fact that there was actually no break in the geological history, but that they were formed during one long and continuous period. As, however, there has been in some cases a considerable lapse of time between the formation of the two, it seems better to divide them.

At the junction of the Copperhannia Creek with the Abercrombie River, a claim known as the "Sounding Rock" has been continuously worked by Mr. Knowles since 1873. The river bears west, and near the junction, the Copperhannia Creek, which has previously had a southerly direction, turns south-westerly, leaving a thin tongue of land composed chiefly of alluvial, and on the eastern end of this the claim is situated. The following section shows its relation to the river and also to Blaney's Claim, which will be referred to later on.



As the river is seventy feet below the top of the deposit, and the wash would only pay if sluiced, it became necessary to make a dam on the Copperhannia Creek sufficiently far from its junction with the River to secure an adequate fall. A race was then constructed, having a length of about three miles. By this means water was brought on to the top of the deposit, and is now available for ground-sluicing any portion of it. At A the drift is exposed in a bank twenty-five

feet high, and, with the exception of the top six feet, it is said to carry gold all through. A little nearer the river a shaft has been sunk twenty feet before reaching bed-rock, the bottom being about on a level with the flow of the water. At the present time operations are being carried on at the northern portion. The wash is in parts bouldery, some of the boulders being several feet in diameter. They consist of quartz, jasper, slate, altered slate, &c., all well waterworn. The gold is mostly fine, with coarse specks up to seven pennyweights, and has a Mint value of £4 3s. 10d. With the gold is associated quartz, topaz, garnet, and zircon; diamonds also are reported to have been found.

This deposit, as already stated, has been proved to run to the level of the present river-flow, but deposits of the same age occur in the district above the level of the present watercourses; as, for instance, on the Mountain Run Creek, where D. M'Vickars has a claim from which he has won a good deal of gold by sluicing. Unlike the deposits in the bed of the river, the work can only be attempted during the rainy reason. The difference between the recent and older alluvium is clearer than at the Sounding Rock, and it is evident from the altitude at which the latter is found, above the former that considerable time has elapsed and the rainfall has much lessened since the close of the older period. The bed-rock is limestone, which has yielded readily to denuding agencies, and formed miniature gorges; therefore, the deposit is patchy, the rich parts isolated, and the formation itself does not appear to belong to any distinct lead. It forms part, however, of an old wide watercourse, resembling the rivers of the present day, which abound in water-holes and pot-holes. The stripping is on an average about twenty feet in width, increasing up to sixty feet, with wash in places four feet thick. The pebbles are well rounded, and consist chiefly of quartz up to ten inches in diameter. The gold is generally coated with iron oxide.

At Cook's Claim, on the Tuena Creek, between Tuena and the Abercrombie River, the necessity for dividing the alluvium into two ages is apparent, as the one occurs sixty feet above the other. The banks of the creek rise abruptly, and the occurrence of a deposit on either slope would not be expected. The wash is eight feet in thickness, and is bouldery in character, some of the blocks measuring four feet by two feet. They consist of quartz, quartzite, altered slate, and diorite (?), all well waterworn. The amount of attrition which the boulders have undergone is remarkable, and would seem to show that the force of the current which brought them into position was strong, rather than that they themselves have travelled any great distance. The drift has been worked for a width of forty feet, and a length of a chain and a half. It is blocked out in the ordinary fashion, and carted down to the creek to be washed. It is said to yield one pennyweight to the load.

Tuena Creek has evidently been of much more importance as a drainage channel in past times than at the present day, and it is surprising that no old channel of

Pliocene age has been found near its present course, or along the Cook's Vale Creek. If one was formed, all sign of it has long since disappeared. There is one small patch of basalt, but it is quite isolated and does not appear to overlie drift.

3. BASALT.

Basalt occurs variously as patches and outliers. Most of the specimens which have come under notice consist of a compact bluish-black variety, with a few small crystals of olivine porphyritically scattered through the mass, and in places a slightly cellular structure with the development of zeolites. To the west of Mulgunnia Station there is a patch running north and south for about three miles, with a width of about a quarter of a mile. About Thompson's Creek, between Tuena and Trunkey, a large patch occurs, but south of Tuena there is very little. Close to the township of Tuena is an outlier, which occupies a small area, and overlies an auriferous drift. The drift itself does not appear to contain payable gold, but it has been partly denuded into a gully close by, and there sufficiently concentrated to pay for working. To the south of Cook's Vale Station is another small outlier. The flows appear to be all of the same age, without any development of the older basalts, which can be well studied about Glen Innes and Inverell, and have been described by the late Mr. C. S. Wilkinson, F.G.S., &c., in various Reports. It is evident that a large area has been covered at one time by basalt, but so intense has been the denuding action since the flow of lava that in places outliers only are now left, where, at one time, there have been thick and large sheets.

4. EOCENE.

These beds are all overlaid by basalt, and consist of sands, clays, gravels, all more or less auriferous, and now, like the basalt, lying frequently in isolated patches, some six hundred and seven hundred feet above the level of the chief watercourses, such as the Abercrombie, the Grove, &c. The deposits define the position of drainage channels, which are the oldest of any in the district, and by comparing their altitude with that of the present channels, some idea can be gleaned of the enormous denudation to which this part of the Colony has been subjected, and the lapse of time between their formation and the deposition those of Pleistocene age. Fossil wood is of common occurrence, and from a shaft sunk by Mr. Nicholls, one and a half mile south-east of Trunkey, close to the Tuena Road, a stratum was passed through which contained an abundance of fossil leaves. A few were handed to Mr. W. J. Lee, the Mining Registrar at Trunkey, who has kindly presented them to the Mining and Geological Museum. The specimens are fragmentary but the following species have been provisionally determined by Mr. R. Etheridge, junr., Palæontologist to the Geological Survey, New South Wales:—

Apocynophyllum Etheridgei, *Ett.*
Ficus Burkei, *Ett.*
Trachyphyllum obtusum, *Ett.*

with the remark, "the first one has been previously found at Dalton, and the two last-named at the Old Rose Valley Lead, which is a tributary of the Vegetable Creek Lead proper."* The fossils are Australian types, and have been found in beds previously recognised as Eocene. The following section has been supplied by Mr. Nicholls:—Ten feet decomposed basalt; five feet fine ferruginous sand; one foot pipeclay, with leaves; eight to ten feet bouldery wash.

The deposits have been worked for gold in three places, but only to a small extent, and they are worthy of much more attention than has yet been given them. In most cases the difficulty has been to secure water in sufficient quantity for washing purposes, as cartage to the creek is generally out of the question. At the southern end of the basalt range, which is to the east of Mulgunnia Station, a rich patch has been worked. The lead was not well defined, and the richest gold occurred on top of a bar five feet above the channel. The lead is supposed to run north, and a couple of shafts have been sunk, with a view of fixing its position; but for want of funds the work had to be abandoned. Schultz and Party are now receiving aid from the Prospecting Vote to drive a tunnel to drain the ground, and should they be successful in striking payable wash, a large extent of country will be opened up.

On the range between Mulgunnia and Camp Creeks a crop of wash runs west, but the prospects obtained have not been encouraging. Parallel to the Copperhannia Creek, and on its eastern side, crops of wash occur in isolated patches. They are auriferous; but, as the hills are steep, the working is attended with difficulty, for if water be obtained by races run round the hillside the catchment area is small and the supply also intermittent; and if cartage be attempted to the creek, four hundred and five hundred feet below, the expense is more than the yield of gold will warrant. At the present time Blaney's is the only claim working. The wash is seven feet thick, and is said to go three pennyweights to the load. The lead is of a bouldery character, some blocks being two and a half feet in diameter, all well waterworn, and cemented by ferruginous clay. The boulders consist chiefly of quartz resembling in appearance birds' eggs, quartzite, altered slate, and decomposed diorite. Three diamonds are reported to have been obtained, two of which were sent to Sydney, and the third one broken on a blacksmith's anvil to prove whether its resistance to a crushing stress was equal to its hardness as a gem.

It is evident that there are portions of the lead which will pay to work, and the difficulty of water supply may, perhaps, in some cases be met by a scheme for pumping from the creeks. The wash itself should be quite rich enough but the question of water has baffled hitherto all attempts to deal with it on a large scale.

* Ann. Report Dept. Mines N. S. Wales for 1891 [1892], p. 268.

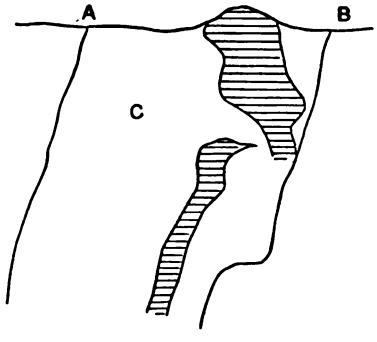
5. GRANITE.

The granite occurs chiefly as dyke-masses, which are doubtless offshoots from a granite boss, and may have some connection with the Bathurst granite on the north, and the Binda granite on the south. It generally makes a good outcrop, but appears to run rather irregularly. As a rule, the dykes have followed the bedding-planes as the most easy passage, and in places have indurated and silicified the rocks at the actual junction, although the alteration does not extend far from the line of union. The rock itself is variable, and ranges in a short distance from a coarse aplitic granite to a felspar porphyry. The masses appear to be of the same age, and there does not seem to have been any later intrusion. The system of upheaval is probably north and south.

6. DIORITE.—A large dyke occurs at the Pine Ridge, and is referred to in the "Annual Report of the Department of Mines for the Year 1877."

7. UPPER SILURIAN.

(*a*) Trunkey District.—These beds occupy a large area, and are of importance about Trunkey, because of the reefs which occur in them. They are certainly older than the Devonian Series which has been mapped by the late Mr. C. S. Wilkinson at Rydal, and are classified as Upper Silurian on stratigraphical grounds only, as no fossils have yet been described, although large deposits of encrinital and coralline limestone are included in the series. In these limestones occur the beautiful Abercrombie Caves, described by Mr. Wilkinson.* The formations comprise sandstones and slates, the latter of a bluish-black colour, with cubes of pyrites sprinkled throughout the rock-mass. At Trunkey the bedding and cleavage appear to be coincident, but nearer the Abercrombie River, along the Tuena Road, the two are clearly seen to diverge. The beds generally have undergone a certain amount of silicification, and by the intrusion of the granite the contact rocks have been converted in places into quartzite, while a study of the outcrop of the reefs would seem to show that the fissuring of the rocks has not stopped at a clean fracture, but that the strata near each crack have been subject to the same movement on a small scale. This can be seen at the Old Pioneer Mine, from which the following section has been taken :—

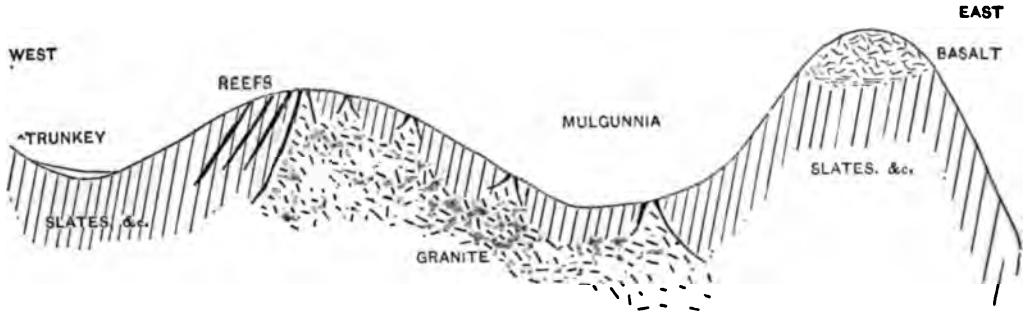


At A and B are defined walls, and at C the beds are separated by white clay, which at first sight might be thought to be interbedded; but evidently it is due to the movement of one layer upon the other with the production of a "dig," which now separates each individual stratum.

The reefs are of interest, not only on account of the quantity of gold which has been, and may again in the future be won, from them, but because of the special mode of their occurrence.

* Annual Report Dept. Mines N.S. Wales, for 1877 [1878], p. 206.

In going from Trunkey to Mulgunnia slates, &c., with reefs are passed over, and then on the crown of the hill there is a change in the formation, as shown on the following sketch :—



At first sight it appears to be wholly an intrusive boss, but closer investigation shows that it consists of sediments intruded by granite.

The occurrence of the metalliferous veins in Cornwall has been carefully studied, and it has been demonstrated that there are two distinct systems of fissures which are due to :—

(1) The fracturing of the sediments by an upheaval of granite.

(2) The fracturing of the sediments and granite due to the depression of the latter.

The conditions under which the Trunkey reefs have formed seem to me to correspond with the first. Denudation has not gone far enough to show the apex of the granite boss, but its existence is indicated by the numerous masses which come to the surface. The second class of veins have not formed in a well-marked series, but they may be represented by the reef dipping east, which has been worked at the New Bathurst Company's Property. As a rule, the veins run nearly north and south, and underlie west ; and although coinciding with the strike of the slates, they underlay at a greater angle. They have been worked to seventy feet, the water-level, for a distance of about a mile, while the line of reef has been found to contain gold for four miles.

The deepest shaft on the field is that of the New Bathurst Company, and stone has been worked at the six hundred and fifteen feet level, where the vein was five inches thick.

At No. 7, Mr. Fulton, the Manager, has sunk a vertical shaft three hundred and twenty-two feet deep, and is now driving east to cut the veins which have been worked at the surface.

It will be seen from the late Mr. C. S. Wilkinson's Report*, that within a width of a quarter of a mile eight distinct veins have been opened, and these vary from two inches to three feet, with an average width of six inches to eight inches. Their outcrop is characterised by the occurrence of large blows of white opaque quartz. The blow itself does not carry payable gold, which is confined to stone half an inch thick either one side or the other, but generally on the western side. The auriferous veinstone forms part of the larger mass, and has often been left on account of the difficulty of detaching it from the barren quartz. Having proved, by carefully trying the soil all around the blow, which side the gold is on, the vein is opened out, and the auriferous stone found to gradually thicken until it occupies the whole width of the fissure, and dips either north or south, but generally north.

An examination of the outcrop shows that on the whole the shoots of gold are regular and of a fair length, in some cases as much as a chain. The amount of dip is more variable than the direction.

Few cross-veins have been found, although one was worked which was in places four feet wide and very rich. The vein is exceptional, and the main line does not appear to have been subject to much faulting, the loss of "stone" being due to the disappearance of the shoot of gold rather than to a displacement of the reef. Considered as a whole the veins are narrow, but with the facilities which there are for working they should afford employment for a number of miners. In many cases the shoots have a fair length, and favour the expectation that, although the difficulties are increased now that the water-level has been reached, the shoots should be profitably worked.

In going over the ground it is hard to resist the impression that the general meridional strike of the sediments is due rather to terrestrial movements than a local cause. The intrusion would seem to have been subsequent to the arrangement of the beds in their present position, and the granite, from which dykes have followed the bedding planes, has fractured the strata, producing cavities into which quartz, &c., in solution, and forming the veinstone, has afterwards infiltrated. The dykes themselves being thin have not contracted much, and there have not been the conditions for the formation of a well-marked series of veins dipping in towards the granite.

The Abercrombie Caves are about nine miles south of Trunkey, and near them is situated the Mount Gray Mine, where there is a large outcrop of quartzite, &c., including slate bands, covering a width of one hundred feet, and which can be traced for several chains in a northerly direction, shutting off close to limestone. On this outcrop a shaft has been sunk forty-six feet, and from the bottom of the shaft there is said to be a drive bearing east thirty-three feet, at

* Ann. Report Dept. Mines N. S. Wales for 1877 [1878], p. 206.

which point a footwall was struck. I was unable to see either shaft or drive as they had both collapsed. The stone varies in character from a slightly ferruginous quartzite to a siliceous ironstone, passing into sugary-quartz, with cubical cavities up to half-inch in diameter, resulting from the decomposition of iron pyrites. From various specimens rich assays have been obtained, and Mr. Grosvenor, the Manager, informed me that a crushing of thirty-six tons taken from the thirty-three feet drive gave a yield of three grains short of seven pennyweights per ton. A tunnel, now three hundred feet in length, is being driven north towards the forty-feet shaft, which is distant three hundred and fourteen feet, and in order to meet it the shaft will be sunk a further depth of thirty feet. The tunnel started in slate, which soon gave place to a highly ferruginous clayey-lodestuff with, in places, boulders of quartzite and angular fragments of slate; then slate was again met with, and at the time of my visit there were signs of more brecciated lodestuff. No defined wall can be seen, although the clay has all the appearance of lodestuff, and with the small amount of work done it is impossible at present to determine whether there is a large fissure or whether a limestone bed has been fissured and partly replaced by silica, &c., from heated waters percolating from below. Near the outcrop there is no sign of limestone, but some specimens of quartzite are calcareous.

To the west of the main deposit is a large mass of limestone, and through it in lenticular patches, are masses of siliceous material similar to the outcrop quartzite already referred to.

At Newbridge brown iron ore occurs in irregular patches in a large lode measuring at least twenty-four feet in width, which is due to an upheaval of granite, and it is possible that the Mount Gray deposit has resulted from a similar intrusion.

Other reefs, such as Wilson's Reef at Pine Ridge, Trunkey Consols, &c., have been worked in the district, though none are at present doing anything.

(*b*) *Tuena District.*—About Tuena several gold reefs, such as the Lucky Hit, are at work, and although the alluvial has yielded a large quantity of gold the lodes have produced principally silver and copper. Peelwood was opened many years ago, and smelting has been carried on at Mount Costigan and Cordillera, but at the present time all are shut down.

The rocks about Tuena differ widely from those at Trunkey, and may possibly be older, but they have not been separated on account of the absence of any evidence to demonstrate the difference in age. Limestone, which has not yet

yielded determinative fossils, occurs within a short distance of Tuena, and there does not appear to be a break in the sequence of the beds, so that it may be that while at Trunkey there is contact metamorphism on a small scale, the alteration in the rocks at Tuena has been greater and more extended.

At Mount Costigan there is a marked belt of altered rocks, measuring one hundred yards wide, and occurring on the eastern or footwall side of the lode, with a series of slates, sandstone, &c., not so highly altered. The belt resembles in lithological occurrence sediments on edge, and the examination of a hand specimen shows the presence of crystals of felspar and blebs of quartz in a siliceous base, the whole having been subject to stresses which have induced cleavage. The rock is probably an altered sediment, and not a plutonic rock, which has assumed a schistose character owing to mechanical movement, and my examination failed to trace any evidence of portions having become so soft as to be squeezed into cavities, and simulate true granite. South of Costigan the character approximates more closely to granite.

The rocks to the west of the Costigan Lode are slates much contorted and more or less indurated and silicified, having a lustrous silvery-sheen due to the cleavage planes. The occurrence at Peelwood of an example of contortion on a small scale has been described by Professor Liversidge.* The Professor concluded, after various inquiries, that the contortion was local, but an examination of the district would have shown that the plication has extended for a length of at least nine miles. There has not been an opportunity of determining the width of the belt, but a projected visit to the south of Tuena may throw some light on this point. The rock varies from a talcose slate to porcellanite, parts of the base being very siliceous, approaching a finely granular quartzite, and becoming quartzose. Examples of true contortion are more common than has been supposed, and occur fairly frequently in various parts of New England.

Mines have been opened out, and smelting operations conducted at Mount Costigan, Cordillera, and Peelwood, but the ore has not been found in any instance outside the original discovery. Whether or not there has been any actual fissuring can only be determined by a careful examination of the deposits, which cannot at the present be attempted. The small portion of the Cordillera Mine which can be seen does not give sufficient information to settle the question, and the evidence which is available points to an irregularity in the deposits, although the absence of defined walls can be fully accounted for by the dissolution of the walls and saturation of the country itself on either side. It is clear, however, that there has been movement, whether of the character to form true fissure veins or not, and coupled with it metallic solutions have circulated through the cavities formed, and it is a

* Minerals of New South Wales, 1888, p. 232.

surprise that more ore-bodies have not been found. That there has been much infiltration of waters with quartz in solution is evinced by the number and size of the quartz-blows, which form a feature in the district. The Peelwood Mine has been worked to six hundred feet, and speaks well for continuity in depth, at any rate, of some of the ore-bodies. It is evident that it would be unwise to spend much money without some favourable sign of the existence of mineral, and it is quite as certain that the driving of a tunnel at right angles to the course of the lode, and not, as in one instance, parallel to it, will not prove the country, because it may happen to cut the fissure or ore-body at the particular point where the walls meet. When a lode is discovered, the rational method of proving it is by following the mineral wherever it may go, and even should it cut out to follow the walls or drive along the lode, and prove whether these may not open and admit of the mineral making. Although at the present time the mines are closed, doubtless there will be employment for many men when the ores are understood better, and the mines worked for the mineral and not for the share market.

Various deposits of ironstone and limestone are found in the district.

IV.—Notes on the Intrusive Serpentine at Gundagai: by P. T. Hammond, Field Assistant.

Whilst on a visit to Brummy's Hill Alluvial Mine, at Gundagai, a few months ago, my attention was attracted by some highly metamorphosed talcose and micaceous slates in the locality, which appeared to pass by imperceptible gradations into the serpentine which outcrops strongly on the west side of the alluvial claim, and from what I then saw the idea was conceived that the serpentine of that locality might have resulted from the metamorphism of the slates. Following out this idea, the junction with the slates on the hill was examined, as closely as the time at my disposal would allow, on the side on which the claim is situated, and found that there was a rather sudden and decided change at this point from the highly inclined slates to the serpentine, which is fairly strong presumptive evidence, taken in conjunction with the crumpling of the strata to be observed at this point, and the presence of ill-defined felspar crystals in the serpentine, that the latter has here resulted from the decomposition *in situ* of a basic eruptive rock which has been intruded along the bedding-planes of the slates.

This eruptive mass can be traced in a northerly direction across the Murrumbidgee River, and through a portion of the town of Gundagai.

Travelling thence along the road to Eurongilly, after passing over an alluvial flat, and following the course of the river for some distance in a westerly direction, a very good section may be seen which has been exposed by the road-cutting, and consists principally of very talcose green slates, passing at times almost into a soapstone, and containing small calcite veins, the beds having a more serpentinous appearance as they approach the junction with the eruptive rock; the alteration having evidently been induced by contact with it. I would, therefore, suggest that this locality is worthy of a closer inspection, which would go far towards settling definitely the question as to whether our serpentines do or do not in any case result from the alteration of sedimentary beds.

I have also observed a similar serpentinous character in the slates at Muttama, and on a hill to the west of the town of Parkes, but have not in either case been able to trace a passage into actual serpentine.

V.—Notes made at the Kybean Caves, Parish of Throsby, County of Beresford, in October, 1890, by W. S. Leigh and R. Etheridge, Junr.: by R. ETHERIDGE, Junr., Palæontologist and Librarian.

[Plate V.]

I.—Locality.

THE Kybean Caves are situated, as reported by Mr. W. S. Leigh*, Inspector of Caves, about twenty miles south-east of Cooma, in the Parish of Throsby, County of Beresford, between two small gullies, branches of a tributary of the Kydra Creek, locally known as the Great Limestone Creek. The Kydra Creek is itself an affluent of the Kybean River, which joins the Umaralla River some little distance above Danjelong Station.

As already noticed by Mr. Leigh, the caves are situated in a limestone spur, running practically north and south, and at an elevation of about fifty feet above the flat of Great Limestone Creek, the rise of the limestone spur itself being a very gradual one. The Kybean is said by the late Rev. W. B. Clarke to be between 3,400 feet and 3,700 feet above sea-level †

* Ann. Report Dept. Mines N.S. Wales for 1890 [1891], p. 311.
† S. Goldfields, 1860, p. 149.

II.—The Caves.

The caves, or rather crevice-chambers, opened out by Mr. S. J. Elphick, the temporary keeper, are five in number. Immediately at the side of the branch creek —in fact, almost in it, and about fifteen chains from its junction with the Great Limestone Creek—is an opening termed the "Bullock Hole" (Pl. V. No. 1.), which at the time of our visit had not been explored, beyond ascertaining that it communicated with the first small chamber of a contiguous opening, called the "Buttress Crevice" (Pl. V. No. 2,). This opening is on the side of the rise, a little above the Bullock Hole, and extends downwards, as a small passage, for forty-nine feet, at an angle of forty-five degrees, in a westerly direction. At twenty feet from the surface is the small off-shoot previously referred to as communicating with the Bullock Hole. At thirty feet from the surface is a small chamber to the left, fifteen feet square, containing a few small stalactites and a buttress formation. The whole is little more than a watercourse crevice filled with blocks of limestone, yellow unctuous clay and *débris*, and marsupial bones, chiefly those of the Kangaroo, Wallaby, and Wombat. The passages are about nine feet square, but would probably be larger if entirely cleared of blocks, &c.

At about thirty paces in a north-west direction from the mouth of the Buttress Crevice, and still going up the rise, is the entrance to the "Danjelong Cave." This is a vertical descent of seventeen feet. From the bottom leads off an irregular passage in a westerly direction, curving round to the north, when it divides into three subsidiary passages. The right-hand opens in height, leading northwards for perhaps twenty to thirty feet, and contains bottle-shaped stalagmites. The left-hand branch is very narrow, passing upwards for a few yards, and contains a little bone-breccia *in situ*. The central passage, equally narrow, is blocked by a very large mass of limestone, probably at some former period detached from the roof. The space between this block and the roof is not more than fifteen inches,* through which the visitor has to crawl in a prone position for about ten feet, landing in a small chamber some twenty by ten feet in area, which again communicates by a very small passage with a terminal chamber. Here are displayed the best stalactites of the whole group of passages and crevices, and although not of large size they are well formed and intact, probably owing to the difficulty of access over the block of limestone previously referred to, for these caves had, to some extent, been visited and vandalised before they came under the notice of the Department. Mr. Leigh thus refers to the contents of this cave:—"A very fair collection of stalactites and stalagmites of various forms, some of which are pure white, and almost transparent, whilst others are of a light-brown tint."

*Leigh, Ann. Report Dept. Mines N. S. Wales for 1890 [1891], p. 311.

The portion now forming the right-hand branch was probably once a small chamber, but is filled below its present floor with successive layers of bone-earth and stalagmite. At his first visit, Mr. Leigh was successful in discovering a layer of bone-breccia in this part of the cave, and remarks in his Report:—"I examined the cave very minutely during this inspection, and was successful in finding, in its lower depths, a layer of bone-breccia, about two feet six inches thick." Between the occasion of this Report and that of our visit, Mr. Elphick had sunk into this deposit to a depth of eight feet, without reaching the limestone below, and had passed through several layers of bone-earth.

About eighteen paces further on towards the crown of the rise is the entrance to the "Elphick Cave," a vertical hole fifteen feet deep. Two branches lead off, one a little east of north for about twenty-two feet, descending at an angle of twenty degrees, and just large enough to crawl through. It is partially filled with red earth. The second passage has a nearly western direction, ending in a small chamber about fifteen feet square, although lofty. A communication exists with the exterior by a small air-hole, high up in the roof of the chamber, opening to the day at some point further up the spur.

There are a few stalactites, and some bones were found by Mr. Elphick loose in the red earth of the floor.

Leaving this cluster of openings, and proceeding a little further up the creek, on the side of the limestone rise, is another vertical hole, leading to the "Kydra Cave," sixteen feet deep. A very irregular passage, both in width and height, is then traversed for sixty feet. It is filled to a great extent with large blocks of stone and earth; but at the entrance there are successive stalagmitic floors containing sparsely-scattered bones. The stalactites are insignificant, but the sides of the passage are covered with a buttress formation.

The size of the caves and the stalactites were not considered of sufficient importance by the Inspector to warrant him in recommending any further outlay in connection with these openings, nor is there that extent of limestone which would lead us to anticipate any very large and important chambers. In fact, the whole of the openings appear to have been drainage channels into which surface material has been repeatedly washed, the passages here and there opening out into small chambers, in some of which the transported material became settled down and roughly interstratified with stalagmitic floors, each one of these denoting a quiescent period, when no new matter was added.

III.—Red-Earth Deposit.

From a strictly geological point of view, the deposit of red earth, sometimes ossiferous, and the stalagmitic floors are the most interesting points about the Kybean Caves, although of so limited an extent.

In general appearance the red earth more or less resembles that of the Wellington Caves, but is of a less decided colour, and, in comparison, but sparingly ossiferous. Its position in the various passages has already been described, but the principal deposit is in the central division of the Danjelong Cave, where it was sunk into to a depth of eight feet without reaching the limestone bottom of the passage. Most of the rock crevices and two or three smaller passages are similarly filled.

In the collection of bones made there is an entire absence of the extinct genera of our Post-Tertiary Marsupials, such as *Nototherium*, *Diprotodon*, *Thylacoleo*, or *Thylacinus*. The remains appear to be those of Kangaroo, chiefly limb bones, with traces of the Wombat. From this it may be justifiably concluded that the accumulations in the Kybean Caves belong to the latter period of Cave-deposits, and not to the more ancient, such as those of the Wellington Caves.

IV.—The Kybean Limestone.

The limestone does not show any determinate strike or dip, but appears above the surface in irregular blocks and patches of no great dimensions. It weathers externally a dark blue-grey in colour, but on fracture is usually white, with yellow and yellowish-red blotches. The texture is homogeneous and highly crystalline, and, so far as I saw, quite unfossiliferous. This is unusual, as most of our cave-limestones are crammed with organic remains. The limestone forms a more or less elongately triangular patch, tailing off in a north-easterly direction in a long, ill-defined, tongue-shaped line. On the rise to the east the flaggy shales strike almost due north, with an easterly dip at fifty degrees, but in the main creek, to the south-west of the limestone, the strike is N. 10° W., the dip still easterly, varying from forty-five degrees to vertical. The surface is quite devoid of timber, the re-appearance of the latter along the north boundary forming a well-marked line of demarcation between the deposit and the enclosing shales and grits.

The only evidence we possess as to the age of the Kybean Limestone is furnished by a few fossils obtained by the late Rev. W. B. Clarke, F.R.S., from the shales and mudstones of Danjelong. These were determined by the late Professor L. G. De Koninck, and are as follows :—*

Ptychophyllum patellatum, *Schl.*
Strophomena pecten, *Linn.*
Pterinea ampliata, *Phill.*

So far as an opinion can be formed from so limited an amount of material, the beds in question would appear to be Wenlock.

* Rech. Foss. Pal. Nouv.-Galles du Sud, Pt. 1, 1876, p. 12, *et seq.*

VI.—Notes on the Teeth known as *Sceparnodon Ramsayi*, Owen (*Phascolonus gigas*, Lydekker): by W. S. DUN, Assistant Palæontologist and Librarian.

[Plate VI.]

I.—Introduction.

A CONSIDERABLE amount of speculation has already been indulged in respecting these peculiar teeth, which were first described by Sir Richard Owen, from specimens sent to him in 1881, chiefly by Dr. E. P. Ramsay. These teeth were found in Post-Tertiary deposits at Lake Eyre, South Australia, Gelgoine Station, New South Wales, and King's Creek, Queensland. Since that date a considerable number have been found at Bingera, in deposits considered by Mr. W. Anderson* to be of Pleistocene age. Other specimens have been found in Queensland.

In this Paper it is the intention of the Writer to give a brief review of the conclusions arrived at by previous observers on the subject, and to describe some additional specimens of single teeth in the collection of the Mining and Geological Museum of the Department of Mines, Sydney.

II.—History.

In 1883, Sir Richard Owen† described and figured casts and specimens of teeth from Lake Eyre, Gelgoine Station, and King's Creek. He described these as rootless scalpriform teeth, and considered that they belonged to an animal almost appoaching *Diprotodon*, *Nototherium*, and *Phascolonus*, in point of bodily size, but widely separated from them by reason of the abnormal flattening of the incisors. The section of these teeth, from the proportion of the enamel, cement, and dentine, more nearly corresponds to those of the Wombat than of any other marsupial. He notes the bevelling of the inner surface, the curve of the cutting edge, the presence of a median ridge, and the fact that on the inner edge there is a depression, probably caused by the pressure of a contiguous tooth. Sir Richard Owen considered that these teeth represented the upper incisors of an extinct marsupial, more similar to the Phascolomyidæ than to any other family, but differing from them by the great breadth of the upper incisors.

The next to describe these teeth was Mr. R. Lydekker,‡ who, noticing in 1887 that whereas there were no specimens of *Sceparnodon* showing cheek-teeth, and that no upper incisors had been assigned to *Phascolonus gigas*, suggested

* Records Geol. Survey N. S. Wales, 1889, I, Pt. 2, pp. 116-125.
† Phil. Trans. R. Soc., 1884, 175, Pt. 1, p. 245.
‡ Cat. Foss. Mamm. Brit. Mus., Pt. V, pp. 157, 158.

that the incisors hitherto known as *Sceparnodon* might be in reality the upper incisors of *Phascolonus* (*Phascolomys*) *gigas*. He supported this suggestion by the following evidence*:—"1. The incisors of *Sceparnodon* agreed fairly well in relative size with the jaws and cheek-teeth of *Phascolomys* (*Phascolonus*) *gigas*; 2. the incisors of *Sceparnodon* were decidedly of a wombat-like type, differing mainly from those of existing Wombats by their large size and excessive flattening and expansion; 3. one of the incisors of *Sceparnodon* agreed so closely in the structure of the enamel, and the reddish stains upon the same, with an upper premolar of *Phascolomys gigas*, that I even suggested both teeth might have belonged to the same individual animal." After this Mr. Lydekker examined three imperfect incisors of *Sceparnodon*, and part of the right ramus of a mandible of *Phascolonus gigas*, from Bingera, which formed part of the Department of Mines exhibits at the Crystal Palace during the late Mining and Mineral Exhibition. From the examination of this portion of the lower jaw he gathered sufficient evidence to justify the alteration of *Phascolomys gigas* to *Phascolonus gigas*, and, as regards the great width of the anterior part of the symphysis, considered it "as being apparently adapted to fit with the wide upper incisors, described as *Sceparnodon*." From the further examination of the *Sceparnodon* teeth, and comparison with the lower molars of *Phascolonus*, with which, allowing for their excessive width, they were not out of proportion, Mr. Lydekker arrived at the conclusion "that we are now justified in definitely regarding the so-called genus *Sceparnodon* as based upon the upper incisors of the gigantic extinct Wombat known as *Phascolonus*," and that "from the great width of the upper incisors, as compared with the lower ones, it is pretty evident that the former must have worked somewhat obliquely against the latter."

Another very important Paper, however, has just been contributed by Mr. C. W. De Vis,† Curator of the Queensland Museum, in which he records the discovery of an incisor of *Sceparnodon* with part of the præmaxilla still attached. From the examination of this portion of the præmaxilla, Mr. De Vis considered that *Sceparnodon* could not have belonged to the Phascolomyidæ, because of the smoothness of its inner edge and the absence of any sign of sutural junction, both of which points are reversed in the family Phascolomyidæ. He likewise describes a smaller imperfectly-developed tooth with a greater extent of working surface, which he considers to be a lower incisor. In this paper Mr. De Vis lays especial stress upon the following points:—1, the absence of a median ridge in some specimens; 2, the relative extent of the working surfaces; 3, the presence in some teeth of a well-marked depression on the inner border.

The tooth described by Mr. De Vis as a lower incisor is characterised by the presence of a well-marked median ridge, a larger proportion of abraded surface, and the presence of a strongly-marked depression on the inner side, which he

* Proc. R. Soc., 1891, XLIX, pp. 60–64.
† Proc. Linn. Soc. N.S. Wales, 1891, VI. (2), Pt. 2, p. 258.

attributes to the chopping action of the upper incisors. From the consideration of this evidence it must be admitted that there are two separate forms of teeth, and that these are either to be considered as upper and lower incisors respectively of *Sceparnodon*, or else, for an alternative, we must imagine that there are two species of *Sceparnodon*, of which the upper incisors alone are known.

III.—Description of new Specimens.

The specimens about to be described were collected at Bingera, in 1888, by Mr. C. Cullen, Collector to the Geological Survey. The alluvial deposits they occur in are of Pleistocene age, and have been described by Mr. W. Anderson,* Geological Surveyor.

The specimens are about thirty in number, and consist principally of fragments, most of which, however, show the working edge of the teeth. They all present the characteristic colour of the Bingera fossil bones, being of a pale-fawn tint. The outer surface is convex, and covered with a coating of enamel, about a millimetre in thickness. This surface is roughly striated, whilst the inner concave surface has fine longitudinal lines running parallel to the sides, in some cases there being also a strongly-marked median ridge. I have been able to divide these teeth into two distinct classes, the one consisting of those with well-marked depressions on their inner edge, the other having merely a worn surface without any marked scars caused by abrasion. From the examination of these teeth, I cannot agree with Mr. De Vis that the median ridge is to be considered as a characteristic sign of any particular set of teeth, as it is by no means confined to those which show the action of chopping, but is most markedly present in several which merely exhibit a bevelled inner edge. Of these two kinds of teeth, those having the strongly-marked depression on their inner edge have invariably a larger expanse of working surface, which is continued downwards on the outer edge of the tooth in a tapering tongue. Of the first class of teeth, which, apart from the fact that some of them do not possess a median ridge, may be considered to agree with those considered by De Vis to be lower incisors, it may be mentioned that the working edges of some show a decided wearing away, the sharp edge being replaced in one case by one 1·4 mm. thick, several others showing this in a less marked degree, whereas one, Pl. VI, Fig. 6, shows that the corner of the inner edge has been broken away and subsequently worn smooth by the action against an opposed tooth. This form of wearing seems to favour the opinion that the tooth in question was an upper incisor, and opposed to a lower tooth which was much narrower in shape, more nearly approaching those of *Phascolonus gigas*.

* Records Geol. Survey N.S. Wales, 1889, I, Pt. 2, pp. 116-125.

Dividing the teeth into two groups—the one (A) possessing a strongly-marked abrasion, the other (B) showing merely a worn surface—we get the following results from a comparison of the measurements of, 1st, the depth at the middle of the working surface, and 2nd, the length of the cutting edge:—

Group A.—Five specimens—average depth of working surface	15·4	mm.
Maximum depth	19	mm.
Minimum do	10	mm.
Group B.—Eight specimens—average depth of working surface	16	mm.
Maximum depth	20	mm.
Minimum	12	mm.

Showing an excess in favour of the teeth in group B of about 6 mm.

Group A.—Five specimens—average length of cutting edge ...	39·8	mm.
Maximum do do do ...	42	
Minimum do do do ...	38	mm.
Group B.—Eleven specimens—average length of cutting edge	39·7	mm.
Maximum do do do ...	42	
Minimum do do do ...	35	mm.

Showing a slight excess in favour of Class A.

From this comparison we see that whereas the teeth of Group B have a greater depth of working surface they have a slightly shorter length of cutting edge. These differences of depth of working surface and length of cutting edge hardly seem sufficient to separate the teeth into upper and lower incisors respectively; and I think that it is most probable that those teeth showing the scars on their inner edge are, as Owen and Lydekker describe them, upper incisors, and that the scars show the limit of action of the lower incisors. So far as this class of teeth is concerned, there is no evidence beyond their abnormal width and fragile nature counter to the fact that they may represent the upper incisors of *Phascolonus gigas*, or of some extinct marsupial possessing a somewhat similar type of lower incisor. But if we take this as conclusive, the position of the second class of teeth has to be determined, and they seem to show no marked scarring similar to the teeth in Group B; and again we have the upper incisor described by Mr. De Vis, which shows no scar, and is still attached to a portion of the præmaxilla.

Owing to the fragmentary state of all teeth which have as yet been brought to light nothing can be stated with perfect certainty. Two most conflicting statements have been made, one Author stating that the lower jaw is occupied by Phascolomine incisors, while the other describes teeth of another type as holding that position. The evidence before us, while showing that there are two classes of teeth, does not prove either of the former opinions to be erroneous, though certain of the characteristics claimed by Mr. De Vis for the lower incisors have been proved to be by no means constant.

VII.—Notes on the Occurrence of Opal in New South Wales: by WILLIAM ANDERSON, Geological Surveyor.

OPAL has long been known to occur in many localities in this Colony, but until the discovery of the opal-field near Wilcannia, the individual specimens obtained had not been of sufficient size or brilliancy to initiate a commercial demand for the gems. Of late years the supply of Australian opal has been derived chiefly from Bulla Creek, Queensland, where it occurs in the form of kernels, filling the centres of ironstone nodules. They usually attain a considerable size, and a large percentage of them consist of precious opal.

In New South Wales precious or noble opal has been found in small quantities, along with the inferior qualities, at Rocky Bridge Creek, Abercrombie River, County of Georgiana, in an amygdaloidal basalt; at Trunkey; in clay ironstone in the Wellington District; at Louisa Creek; at Bland, near Forbes; at Coroo, with chalcedony, agate, &c.; and at Bloomfield, near Orange.

Common opal and opalised wood are of very frequent occurrence in all the Tertiary basaltic districts of the Colony, but they are of no commercial value, because, although they take a high polish, they want the brilliancy and play of colours which belong to the precious opal.

Opal generally occurs as a secondary product in igneous rocks, sandstones, limestones, and in some metalliferous veins. It is usually the result of the deposition from solution of opal-silica in cavities during its percolation through the rocks. It is, however, sometimes deposited from hot springs. The cavities which it occupies in rocks may be cracks or joints, or the hollows left by the decomposition of various minerals. The substance of the opal is often rendered impure by remnants of the decomposed constituents of the rock, as well as by the presence of hæmatite and other foreign materials. The most valuable variety, precious or noble opal, is of comparatively rare occurrence, its chief sources being Hungary and Central America. The other less valuable varieties are met with frequently in many other parts of the world.

The locality in which opal has recently been discovered in New South Wales is known as the White Cliffs, on Momba Holding, about sixty miles in a north-westerly direction from Wilcannia. The country in this neighbourhood forms part of the great western Cretaceo-Tertiary Plains, and is, consequently, flat, with here and there a few isolated hills rising from it. The plain-like country is formed of horizontal Cretaceo-Tertiary strata, while the hills and rising grounds consist of

various formations. To the west of Momba they consist of vertical Silurian slates and horizontally-bedded Devonian conglomerates and sandstones, both of which represent the denuded summits of the land surfaces which existed in this area during the deposition of the Cretaceo-Tertiary beds. Besides these, however, some of the rising grounds are formed of very siliceous, horizontally-bedded sandstones, which undoubtedly belong to the Upper Cretaceous, and are probably equivalents of the Desert Sandstone of Queensland. These latter are very easily mistaken for outliers of Devonian sandstone, the mode of occurrence and general configuration of the denuded outliers of the two formations being very similar; although the Devonian rocks are always ferruginous and dull, while the Desert Sandstones are usually a pure white, hard, glistening, siliceous sandstone, with almost a vitreous look.

The opal in its occurrence here is confined to the vitreous-looking Desert Sandstone, and the alluvial deposits which have been formed from its denudation. It, chief source is, however, the sandstone, in which it occurs in the three following positions:—

1st. Disseminated in minute fragments throughout the substance of the rock.

2nd. Coating the joints and fractures.

3rd. Occurring irregularly, as definitely-shaped pieces, which have resulted from the replacement of fragments of fossil wood, shells, &c., or the filling of cavities which have been left vacant by decomposition.

In the first position (disseminated through the rock) it is in very minute, irregularly-shaped fragments, which fill up the interstices between the grains of sand forming the sandstone, and presents the appearance of being the cementing material of the rock, although it has undoubtedly originated as a secondary infiltration. When slabs of the rock, abundantly infiltrated with this opaline material, are cut and polished the effect produced is remarkable, presenting a minutely kaleidoscopic effect, from the variegated play of colours which the individual pieces of opal possess. This opal, so far, is of no commercial value as a gem; but it might be largely utilised for inlaid work in jewellery, and for supplementing the internal decoration of buildings for which tiles and marble are now used.

In the second position (coating the joints and fractures) the layers of opal are, as a rule, of no great thickness, but its quality is generally fairly good, and it possesses to a considerable degree the play of colours which is so characteristic of the better varieties of this gem. Much of this joint-opal is so thin that it could only be used for inlaid work. There is, however, a considerable proportion of it which is of sufficient thickness to allow of its being cut and polished as gemstones.

In the third position the opal occurs as definitely-shaped pieces scattered through the substance of the rock. In size they vary greatly up to a foot in length. This opal has originated in various ways, as follows:—

1st.—By replacement of fossil wood.

2nd.—By replacement of Invertebrate forms, chiefly Mollusca.

3rd.—By secondary filling of cavities formed by decomposition.

In many of the opals which have originated from fossil wood, the minute structure of the wood can still be detected, even by the naked eye, the fibrous tissue of the wood having, during its fossilisation, been replaced by opal-silica. In many specimens of opalised wood, where the entire thickness of a branch has been opalised, the major portion of this usually consists of dull milky-white common opal, the radial cracks from the centre being alone composed of clear opal showing a brilliant play of colours.

In the second form of replacement the entire substance of shells, segments of encrinite-stems, &c., have been converted into opal, in fact, complete opaline casts of mollusca have been obtained, whose surfaces show considerable play of colours. This is a remarkably rare form of the replacement of fossil mollusca by opaline matter. Already some of the more perfect specimens of opalised shells have been sold by jewellers at high prices. There is every reason to believe that this process has really been in most cases an actual replacement of the shell substance, and not merely a filling of a cavity formed by the disappearance of the shell by decomposition.

In many cases the opal shows no woody structure, nor does it present the shape of any Invertebrate form. It is probable that in some of these cases the opal has been deposited from solution in cavities which had been formerly occupied by fragments of wood, whose minute structure had not withstood the processes of fossilisation. The larger fragments, exhibiting no minute structure, are generally of a milky-white or honey-yellow colour, and do not show much play of colours; but many of the smaller pieces, which have evidently been formed in cavities left by the decomposition of individual fragments of wood, &c., are of good quality, and are tinged with bluish and purplish hues, presenting considerable play of colours.

Owing to the very irregular mode of occurrence of opal in the sandstones near Wilcannia, and the fact that it does not occur in defined lodes, the methods adopted to obtain it necessarily differ somewhat from ordinary mining operations. The outcrops of the sandstones are carefully searched for any traces of opal, and when these have been discovered the specimens are picked out by hand. No deep shafts are sunk, as in the case of mining for metals. The only positions in which

they are sunk (and that only a few feet) is where there is a joint carrying good opal, but the blasting of the rock enclosing the opal necessarily breaks up the specimens of the gem. There is, therefore, great difficulty in obtaining the opal from the sandstones, which are of considerable hardness. In other parts of the world it is usually obtained from the decomposed portions of volcanic rocks, from which it can be readily picked without the danger incurred by first having to blast or break the matrix enclosing it. There is no method of producing artificial decomposition of the matrix (such as is done at the diamond-mines in South Africa for the extraction of diamonds), because the rock is of so siliceous a nature that it is almost impossible to disintegrate it; in fact, at the exposed faces of the cliffs there is remarkably little sandy detritus resulting from the natural degradation of the sandstone. It, therefore, appears to me that the extraction of the opal from the Desert Sandstone is only possible in the immediate neighbourhood of the surface outcrops, but there are probably large areas of alluvial in the vicinity of the cliffs which might be rich enough in commercially valuable opal to repay working by the ordinary methods of auriferous alluvial mining.

VIII.—Note on the Intrusive Porphyry at Melrose: by P. T. Hammond, Field Assistant.

Although many localities are generally known in New South Wales in which the junction of highly-altered sedimentary rocks, with the igneous rocks which have probably caused their alteration may be observed, I am not aware that any have been placed on record. The examination of such junctions is of great geological importance, as we must rely principally on such evidence as this would afford to explain the origin of many rocks in New South Wales that have been considered elsewhere to result sometimes from extreme metamorphism of sedimentary beds whilst at others they occur as almost undoubted igneous rocks.

It is my intention to place on record such localities as may from time to time come under observation. A systematic list might subsequently be prepared, and would doubtless be of use in directing attention to these localities.

Very little systematic work has yet been done with regard to our igneous and metamorphic rocks, and the close examination of the boundaries of apparently intrusive rocks, at their junction with undoubted sedimentary beds would place beyond doubt the origin of such rock-masses.

Starting from the one-mile marked tree on the road from Melrose Homestead to Mount Tinda, Parish of Gindoono, County Cunningham, and going in a north-easterly direction, a section may be seen showing a gradual transition from the highly-inclined Silurian slates, striking N. 10° W. and S. 10° E., through all stages of metamorphism, till one arrives at the crest of a hill which appears to be the southerly extension of a spur from the main range which forms the northern boundary of the country; this hill lies to the south of Mount Susannah (a conspicuous hill in the same spur). Here an apparently eruptive porphyry has been intruded along the bedding planes of the Silurian strata, causing them to assume a porphyroid structure, simulating very closely the appearance of the eruptive rock itself, in which also a false-bedded structure has been induced in places by the lateral pressure of the associated strata.

This structure renders it difficult to distinguish the actual boundary-line of either rock, and this is only rendered possible in the field by the much greater lamination of the altered beds, which still retain much of their original structure, though some beds occur in which every trace of this has been obliterated.

Such beds resemble quartz porphyry, with both quartz and felspar porphyritically developed, and even felsite, while others just as highly altered, yet contain waterworn quartz pebbles, showing that they were originally conglomerates.

I have also observed an almost exactly similar rock to some of these beds, which still contains the casts of crinoid stems plainly discernible throughout its mass, putting beyond question its sedimentary origin.

This rock occurs on a hill on which some prospecting for silver has been done, situated about a mile and a half in a west-south-westerly direction from the thirty-mile marked tree on the Melrose to Condoubolin Road.

IX.—Idiographic Drawings of the Aborigines in a Rock-shelter at Weeny Creek, Colo River, near Richmond: by R. ETHERIDGE, Junr., Palæontologist and Librarian.

UNDER the guidance of Mr. J. P. Collins, Head-master of the Superior Public School at Richmond, Hawkesbury River, and accompanied by Mr. C. T. Musson, F.L.S., an inspection was made of a Rock-shelter in a tributary gully of Weeny Creek, Colo River, about eight miles north-west of Richmond, and some three-quarters of a mile off the Comleroy Road.

The aboriginal name for these Rock-shelters appears to have been that of "Gibber-gunyas," literally, "houses of rock," at any rate, in the Port Jackson and Hawkesbury Districts. The late Mr. Surveyor Govatt, in describing the country between Port Jackson and Broken Bay,* refers to the shelters in the Hawkesbury Sandstone, on ridges dividing the Cowan and Berowra Creeks: "These caves, or hollows," he remarks, "are called by the natives gibber-gunyas, or houses of rock."

The Shelter near Richmond is situated on the bank of a small gully, and is of the usual type of those met with in Hawkesbury Sandstone country, hollowed partly by fluviatile action, partly by atmospheric influences, out of a long low escarpment of rock. The Shelter is twenty-five feet long, eleven feet deep, and eight feet high inside; but, on account of its dome-shaped interior, only four and a half feet at the entrance. The walls have been much defaced by vandalistic writings and smudgings, but the previous aboriginal contributions are still plainly visible. They consist of about a dozen hand-outlines of different sized figures of "Iguanas," one of them four and a half feet long, a flying squirrel, boomerangs, and a tomahawk, mounted on its handle, nine inches in length, all reproduced by splash-work. A good deal of touching up has unquestionably been done by visitors, but I have every reason to believe that the objects mentioned are genuine; indeed, the renovation simply consists in re-outlining the figures with charcoal.

This Shelter, with its drawings, has been known for fifty years. The late Mr. G. Day, of Comleroy, informed Mr. Collins that even then the drawings were beyond the knowledge of any of the local blacks.

The floor of the Shelter is stone, and in consequence there is no room for interments; neither is there any trace of hearth rubbish, leading to the belief that the recess had not been used to any great extent as one of residence.

Idiographic drawings have been known from the time of the earliest explorers, and are usually depicted either in black on the flat, or simply in outline. Flinders† refers to them, on the rocks of Chasm Island, Gulf of Carpentaria, in black and red on a white ground, representing turtles, kangaroos, and the human hand. Cunningham‡ described figures of sharks, porpoises, turtles, lizards, trepang, starfish, clubs, fish, and canoes done in white outline on a groundwork of red, on the roof and sides of caves at Clark Island, Cape Flinders.

The practice of hand-imprinting, almost universally distributed over Australia, appears to have had little attention paid to it, comparatively speaking. Mr. Alfred Howitt, in his "Notes on the Aborigines of Cooper's Creek,"§ says:—"Among the

* Sketches of New South Wales, No. XII. *Saturday Mag.*, 1836, IX, No. 284, p. 223.
† Voyages, ii, p. 158.
‡ P. P. King's Intertropical Coasts of Australia, 1827, II, p. 26.
§ Smyth's Aborigines of Victoria, 1878, II, pp. 300-309 [p. 309].

back-country blacks at the Barrier Ranges there is a custom of making 'rock-paintings.' That is, the figure of an outstretched hand, sometimes colored, sometimes plain on a colored ground. When the former, the hand is daubed with red ochre or pipe-clay and printed off. The latter mode is to place the extended hand on the rock, and to squirt color over it out of the mouth; on the hand being removed, the print is left on a colored ground." In Western Australia, according to Mr. H. Y. L. Brown,* the hands are blackened, and then pressed against the stone. He saw, remarks the late Mr. R. B. Smyth, "one cave in granite rock where there were many such figures of hands of different sizes, the form of each being cut out very neatly."

On the other hand, the late Mr. E. M. Curr considered such hand-imprints of no import, "unless it be the first step in imitative art."† He also remarked:—"As I have often myself seen the blacks imprint their hands stained with red ochre on suitable surfaces in this way, I cannot accept such marks as a proof of antiquity."‡

Although it is, of course, quite possible that to many of the later degenerate Aborigines hand-imprinting may have been simply a matter of sport and pastime, yet evidence exists of the antiquity of this practice, and it is of too much importance to be dismissed in this hurried and conclusive manner. It must not be forgotten that the habit, or even perhaps rite, of hand-printing on surrounding objects was in vogue with the ancient inhabitants of the Deccan, the Dravidians, from whom the Australian blacks are to some extent supposed to be descended. Such an affinity is further supported by the use of the boomerang, and many points of similitude in the two languages. Speaking of the Dravidians, Dr. A. Carroll says:—"They use. projectiles like the Australian 'boomerang' . . . . . They made prints of a red hand on rocks, trees, &c."§ The same Author further remarks:—"Thus we find the 'stencilled or painted' hand in Australia pointing to the rites connected with evil deities . . . . and this same 'red hand' points to the Siwa and Durga worship in India, and the prevalence of these there, as do similar markings on the rocks, trees, &c., of this land."‖

The tribe at the mouth of the Leichhardt River marked their *Bora* grounds with peculiar signs, amongst others a hand painted on a conspicuous tree, with red ochre or blood, or chopped out of the bark;¶ and Flanagan even states that shields are at times ornamented with figures of hands, more particularly the shield known as the *Eleman*,** but I have not found any support to this statement.

* Smyth, *Loc. cit.* I, p. 291.
† Australian Race, 1886, II, p. 301.
‡ *Ibid*, 1887, III, p. 679.
§ Sydney Quart. Mag., 1889, VI, No. 2, p. 126.
‖ *Ibid*, No. 3, p. 206.
¶ W. E. Armit in Curr's Australian Race, 1886, II, p. 301.
** Aborigines of Australia, 1890, p. 84.

Mr. J. Bonwick describes* a cave at Rylstone, in which are the impressions of red hands, some with the forefinger cut off, others crossing one another. He remarks:—"Amongst the tribes of ancient Egypt, and monuments of the Peruvians and Mexicans, the red cap and red hand are common, and evidently refer to some universally-spread mystery, some lost freemasonry." The bottom of this cave is said to be "paved."

In West Australia these Shelters are known under the name of *Dumbun*, and one near York is thus described by the Hon. George Fletcher Moore, many years ago Advocate-General of that Colony:—"The only vestige of antiquity or art which has yet been discovered consists of a circular figure rudely cut or carved into the face of a rock, in a cavern near York, with several impressions of open hands formed on the stone around it. The natives can give no rational account of this. They tell some fables of the moon having visited the cave and executed the work. They have little curiosity regarding it, and pay it no respect in any way. In short, it appears as if it did not concern them, or belong to their people. . . . This rude carving at York may possibly be the last trace of a greater degree of civilisation proceeding from the north, and becoming gradually more faint as it spreads to the south, till it is almost entirely obliterated; or, again, it may be the only monument now left to speak of a former race, which has altogether passed away, and become superseded by another people."†

Whatever, therefore, is the nature of these pictorial hands, and however much opinions may disagree, they are, nevertheless, worth investigation—the very difference of opinion amongst Authors rendering them so. Too many facts cannot be collected, and this done, some generalisation of a definite nature may perhaps be arrived at. My Colleague, Mr. P. T. Hammond,‡ observed imprints in the Rock-shelters of Wollombi that he believed to be those of women or children, judging by their size. If his supposition be correct, it is exceedingly interesting, for the absence of hand-markings attributed to women has been commented on more than once. At the same time it must not be forgotten that the average male aboriginal hand was much smaller than that of the whiteman; witness, for instance, the the small hand-holes in the generality of their shields. Mr. Hammond further comments on the presence in the Wollombi Rock-shelter of one right hand, a very unusual occurrence, and still more so, that of feet. If done in sport, it seems more than probable that this was confined to the younger generations of blacks, who were quite ignorant, from their association with the whites—and, thereby, a loss of the pristine traditions of their race—of the esoteric meaning of these delineations, for a hidden meaning I believe they possessed. Dr. Carroll§ states that "comparative mythology has established the fact that the impression of the left

* William Buckley, the Wild White Man (8vo., Melbourne, 1856), p. 87.
† Descrip. Vocab. Language Aborigines W. Austr., &c., 1842.
‡ Records Geol. Survey N. S. Wales, 1892, II, Pt. 4, p. 175.
§ Centennial Mag., 1888, I, No. 3, pp. 189-191.

hand was the sign-manual of a wizard or sorcerer." He distinguishes several degrees of tribal importance in the representation of the hand. Thus the Wizard crest is "represented by the left hand stencilled or shaded upon the rock-shelters." The sign-manual of the Chief Initiators was a hand "wetted with blood, and the character impressed (not stencilled) upon the rocks." That of the Chief Elder "was a black hand, indicative of the power of declaring war, or even commanding the extermination of a tribe"; whilst the white hand was indicative of the Elder, "privileged to terminate a strife, and despatch the heralds with their 'message-sticks' to hostile tribes." He further points out that hand-symbols have been found on every continent of the globe, and amongst other peoples, the Dravidians in India. Of the wizard's hands, Dr. Carroll gives an excellent illustration, taken from Kangaroo Point, George River, near Botany Bay.

Little more than the hand is ever depicted of one limb, although Sir George Grey describes* the outline of a hand and arm painted black on a white ground on the rocks of the Upper Glenelg River, North-west Australia. This form of drawing is very rare.

X.—The Caves at Goodravale, Goodradigbee River; by R. ETHERIDGE, Junr., Palæontologist and Librarian.

[Plates VII–IX.]

I.—Introduction.

THE following Notes are the result of a recent examination (January, 1892) of the Caves at Goodravale, on the Goodradigbee River, about six miles south of its junction with the Murrumbidgee, made by Mr. John Mitchell, of the Public School, Narellan, and the Writer, when engaged on a preliminary geological exploration of the Goodradigbee Valley as far as Wee Jasper, and the country in a north-easterly direction as far as the Bloomfield Crossing on the Murrumbidgee River.

II.—History.

The existence of caves at Goodravale has been known for many years, but with the exception of a brief remark by the late Rev. W. B. Clarke, F.R.S.,† "that the Coodradigbee (*sic*) caverns will repay research hereafter," and a reference by Mr. Charles Jenkins‡ to the fact that he had visited them, no other mention has been

* Journ. Two Exped. N.W. and W. Austr., 1837–39, I, 1849, p. 204.
† Sedimentary Formations of N.S. Wales. Third edition, 1875, p. 55; Fourth edition *ibid*, 1878, p. 104.
‡ Exploration of the Caves and Rivers of New South Wales (Minutes, Reports, Correspondence, Accounts), *N.S. Wales Parl. Papers*, 1882.—102 A (pp. 52, plates, f. cap, Sydney, 1882), p. 35.

made of these caverns, so far as we are aware. Mr. Jenkins was employed by the Trustees of the Australian Museum (Exploration of Caves and Rivers Committee) to examine the various Caves throughout New South Wales, a work that was not carried out, unfortunately, beyond those at Cave Flat, junction of the Murrumbidgee and Goodradigbee Rivers, and that only in a very partial and imperfect manner.

In one of his letters to the Committee, Mr Jenkins stated* that "there are a great many caves (at least a dozen) on the Coodradigbee (*sic*), most of which I have been in; some, however, have been discovered that I have not seen of any great length, as I learn with many ramifications." In another letter† to the same body he fixes the position of the Caves as "near the post in [Portion] 61, parish of West Coodradigbee," and adds, "one is larger than any of those I have yet explored."

III.—Locality.

Our examination was confined to two caves at Goodravale, occurring in a very large belt of limestone, extending from Cave Flat, on the Murrumbidgee, for many miles to the south. The most important of the two caves, and which may be appropriately called the Goodradigbee Cave, is situated about ten yards to the east of the south-east corner-peg of Portions 61–51, Parish of West Goodradigbee, County Cowley, and is therefore identical with that referred to by Mr. C. Jenkins (Plate VII). The second, or Goodravale Cave, as we propose to term it, is on Portion 51 of the same Parish, and is so much inferior to the Goodradigbee Cave that it will demand but a brief notice. In addition to these two caves, we found the entrances, three in number, to a third, and probably much larger cavern, situated on Portion 5, Parish of West Goodradigbee (Plate VII); but from the want of proper appliances, and our limited party, we were unable to descend the narrow, deep, and vent-like orifices leading to it.

IV.—The Caves.

1. The Goodradigbee Cave.—The low entrance is situated on the limestone rise to the east, and above a small alluvial flat in the gully forming an arm of a large swamp extending over parts of Portions 3, 4, and 30, Parish of West Goodradigbee. A short inclined passage of a few feet leads to an irregular and more or less vertical descent of rather less than fifteen feet, which lands the explorer on the top of the descending talus of the first chamber (Pl. VIII, No. 1), which is here broad-oval in shape, but after narrowing, and the floor becoming level, broadens out into a fine expanse of about seventy feet wide.‡ It has a

* *Loc. cit.*, p. 30.
† *Loc. cit.*, p. 35.
‡ It must be distinctly understood that all the measurements are simply approximate. To arrive at anything like absolute accuracy in so intricate a place as a series of cave-chambers would entail much time and labour, and a detailed survey.

right- and left-hand portion, the latter much the larger and more important, with a rising block-strewn floor, culminating in a small daylight entrance, which can be reached by a little precipitous climbing. The stalactitic, stalagmitic, and stalacto-stalagmitic "formations" in both halves of this chamber are more massive than beautiful, although some delicate stalactites are visible on the roof and sides of the right-hand portion. The first to attract attention is a stalagmitic pedestal (Pl. VIII, *a*), at the point of enlargement of the chamber from the entrance. Other similar pedestals are scattered about, especially round the sides, varying from six feet and upwards in height; but the most important object in this chamber is a very fine stalagmo-stalactitic pillar (Pl. VIII, *b*), arising from the irregular rocky floor of the left-hand portion, and extending up towards the roof, through which a small stream of daylight enters. This pillar must be quite fifteen feet in height, if not more. From this left-hand section of Chamber No. 1 two passages are given off in a generally south-east direction, proceeding to the inner parts of the cave. For the sake of clearness and brevity, these passages may be denominated A and B respectively.

Passage A (Pl. VIII, A), but a few feet wide, descends for a short distance, at an angle of thirty degrees, and then ascends over a red-earth flooring, and with the limestone roof much frosted with incipient stalactites, opens into Chamber 2 (Pl. VIII, 2) a dry limestone cavern without "formation" except a huge mass of limestone and stalagmite immediately at the entrance (Pl. VIII, *c*), but a large quantity of red-earth deposit. This little chamber is about one chain in length, twenty feet wide, and perhaps fifteen high, the large mass at the entrance practically splitting it into two passages, rather than a chamber. This is succeeded by a short passage leading to another dry cavern, Chamber No. 3 (Pl. VIII, 3), similar to the last in character, but longer, and of a greater height, the roof graduating upwards into numerous crevices and cracks, some of them becoming funnel-like. Two short blind passages are given off at the end of this chamber, on the right hand, filled with quantities of red earth, but one of them has a drop or pit in the earth of some feet, and will be referred to again later on. The walls of Chamber No. 3 exhibit a grand display of outstanding weathered fossils, chiefly Corals and *Stromatopora*, similar to those observed by us in the "Hall" at Cave Flat.* Again, a brief narrow passage leads to an irregular small chamber, Chamber No. 4 (Pl. VIII, 4), from which a network of small blind and curved passages lead off, filled with red earth, one in particular, on the left, circling round on itself, and re-entering the chamber. All these small side passages are similar, just high enough for the explorer to traverse in a stooping position, and wide enough for one to pass at a time, irregularly filled with red earth, sometimes much, at other times little, frequently so far filling the passage that onward progress is only made by crawling over the heaps. In a few instances

* Australian Museum, Ann. Report of the Trustees for the Year 1888 [1889], p. 36.

diminutive chambers are met with in the course of these little passages, and when so the "formations" are excessively delicate and pretty. At the end of Chamber No. 4 the main passage takes a sharp turn, opening into a high and very irregular although not large cavern. Chamber No. 5 (Pl. VIII, 5), which has a large right-hand extension, almost at right angles, passes upwards, and is filled with large irregular blocks of fallen limestone and stalagmitic matter, resting on a very irregular floor, rendering the explorer's progress slow, rough, and difficult. The roof has several fantastic masses of limestone hanging from it, and there are a few cascade stalactitic formations. Some of the smaller stalactites are still active. At about one chain from the entrance to Chamber No. 5 rises an exceedingly beautiful stalagmitic pillar, which, from its elevated position on the rising irregular floor, and its glistening surface, presents a very imposing appearance. From the opposite end of Chamber No. 5, a short upward passage leads to another small almost-circular high-roofed chamber, No. 6, containing a small amount of stalactitic formation. At the upper end of the rising floor of this chamber is a downward perpendicular drop in red earth of eight feet (Pl. VIII, *e*), when the passage of communication is resumed, opening into the last chamber (Pl. VIII, 7). It is quite evident that the present red-earth floor of this chamber does not represent its true floor, but that the limestone walls descend some distance below this. At a height of five feet ten inches above the red-earth floor is a fine example of a stalagmitic floor, dividing the chamber into two parts, with, resting on it, a foot of red earth and pebble wash. It stands to reason that at one time this five feet ten inches of space was filled with red earth, which has been subsequently removed. Chamber No. 7 terminates in a passage choked with red earth, and through this we were unable to penetrate. The last few passages and two chambers exhibit traces of bat-dung, but bats themselves were not seen.

Having now arrived at the termination of the main roadway of the cave, or, as we have termed it, Branch A, in all about one hundred and seventy yards, in round numbers, from the actual entrance, we may return to Chamber No. 1, and trace the course of Branch B, in its general direction sub-parallel to Branch A. A gradually-narrowing passage leads to a very fine limestone cavern, Chamber No. 8, about one chain in length, and forty feet wide, containing a few stalactites, particularly a cascade-like mass at the entrance, and others at its further end, illustrating the columnar formation. On the left centre a branch is given off, with funnel-like upcasts high in the roof, containing traces of red earth adhering to the limestone sides, and ultimately communicating with Branch A. At the far end of this chamber, on the right hand, a tortuous winding course proceeds, sometimes passage-like, at others as a tunnel, or again a mere crevice, through which progress is with difficulty made, leading to a very small chamber (Pl. VIII, 9), containing four stalactitic floors, superimposed one above the other. The lowest is three feet above the cave-floor, and those above about four feet apart. Through

these we descended, as through the storeys of a house. From this little chamber a descending passage leads to a lower level, and terminates in a funnel-shaped upcast (Pl. VIII, *f*), through which a large quantity of the red earth has evidently descended from the surface.

Returning to Chamber No. 9, we continued our course along a small curving passage, bifurcating right and left (Pl. VIII, *g*), the latter portion opening into a second small chamber (Pl. VIII, 10), containing a few brown columnar stalactites. At this point a further bifurcation takes place, when, by returning back, as it were, on the left, along a similarly narrow passage as before, but well lined with small stalactites, of more or less beauty, the explorer will arrive at another small almost-circular chamber, with a highly acicular roof, and connected with a passage leading from the right of Chamber No. 8.

Returning to the small Chamber 10, and passing up the right-hand branch, a pit in the red earth is met with, about ten feet deep. This leads to a lower passage, ultimately joining Branch A, leading from the first large chamber. On returning to the right-hand branch, after leaving Chamber No. 9, a similar narrow passage is traversed as before, and the rocky head of Chamber No. 5 is entered, above the fine stalagmitic pillar already referred to (Pl. VIII, *d*). It is evidently supported on a stalagmitic floor, for near its base is a small hole, between limestone blocks, and partially filled with red earth. This leads into a hollow space or chamber under this floor, the base of the large pillars being clearly discernable. The pillar itself is a grand exemplification of the mode of formation of such stalagmitic accumulations. The whole surface is covered with small semi-lunar or crescentic oblique cups or basins, formed by the deposition of the lime from innumerable small drip-spots above, the pillar being by no means the result of deposition from a single large stalactite. At the head of this branch of Chamber No. 5 there is another of the drops or sudden descents, of some feet in depth—about eight feet—communicating with the tortuous passages leading to Chambers Nos. 9 and 10, afterwards curving round on itself, and then communicating with Chamber No. 3.

2. THE GOODRAVALE CAVE.—This is situated on the northern extension of the same outcrop of limestone on Portion 51, Parish of West Goodradigbee.

The entrance is gained by clambering down the steep side of a large broken-in chamber (Pl. IX, 1), now almost wholly open to the day, with blocks of limestone and the remnants of a few stalactites scattered about it. The deeper recess of this chamber narrows to a small archway (Pl. IX. *a*), a good deal obstructed by fallen material, and ushering the visitor into a rather smaller and longer chamber (Pl. IX, 2) which has two branches, a right and a left. The former is completely blocked, except an airway immediately under the roof, with a bank of dry red

earth (Pl. IX, *b*). There can be no question that were this deposit cleared out, other and more defined chambers could be reached. The left-hand branch becomes passage-like for some distance, when it divides, the left-hand branch terminating in a small rather triangular chamber (Pl. IX, 3). The main passage here contains a good deal of red and black earth, and bat's dung, the black earth being the result of the admixture of the red deposit and the dung. A good many stalactites and stalagmitic masses are present, but very dirty, and formation is still going on. The limestone exposed in this cave is highly fossiliferous, the mode of weathering of the component corals resembling that at Cave Flat, and in Chamber No. 3 of the Goodradigbee Cave. Although disappointing, both from its size and dirty state, it is probable that the Goodravale Cave would yield pleasing results if the red-earth deposit could be systematically removed, and the passages and chambers followed out.

3. OTHER CAVES.—If the limestone escarpment be followed in a southerly direction from the Goodrabigbee Cave, many surface-depressions, indicating fallen-in chambers, and small entrance-holes, with intake air-currents may be noticed. One in particular occurs on Portion 5, and is indicated by three deep natural shafts in close contiguity to one another, one perhaps forty to forty-five feet deep, and a second probably about sixty feet. The absence of proper appliances and sufficient assistance prevented our exploring these vertical descents. Their position is approximately shown on Pl. VII.

V.—General Remarks.

The general direction of the strike of the Goodravale Limestone is N. 20° W., and a glance at the plan of the Goodradigbee Cave (Pl. VIII) will show that it approximately follows the strike, whilst the Goodravale Cave (Pl. IX) does so in a somewhat less-marked manner. Both caves consist of a series of large and small chambers, united by passages in some cases of fairly large size, at others narrow, low, and tortuous. They may possess plain limestone walls, or here and there be frosted with small stalactites, which render bodily abrasions on the part of the explorer moderately frequent. Some of these passages have small lateral recesses filled with delicate and elegant stalactitic formation.

I think little doubt can exist that the chambers primarily owe their origin to the action of surface-waters percolating through cracks and crevices along the strike, and by imperceptible degrees dissolving away the limestone, thus enlarging any small natural cavity which may have existed, until space is gained for more vigorous action. That these caves do not represent an underground watercourse, strictly in the sense of a creek-flow, is, I think, certain; but they chiefly acted as surface-drainage channels through cracks and fissures. This appears self evident

when the position and nature of the red-earth deposit is considered. It is nothing more than disintegrated and decomposed limestone, and whenever roof crevices and funnel-shaped upcasts are searched by the aid of the magnesium lamp, they will invariably be found choked with this deposit. Facts of this nature have been referred to in more than one instance during the previous description of the several chambers. That considerable bodies of water entered these caverns is also clear from the stratified nature of the deposit, and especially the presence of the pebble-wash in Chamber No. 7 of the Goodradigbee Cave, associated with the stalagmitic floors. The latter are very remarkable, and illustrate in a general way the number of more important inrushes of sediment that have taken place. Similar floors are described in the Belubula Caves by the late Mr. C. S. Wilkinson. The position of the small mouth of the Goodradigbee Cave is such, above the level of the wide alluvial flat, bordered by the limestone escarpment, that an immense body of water would be required to fill the valley before an inroad could be made into the cave. I believe that many of the caves throughout New South Wales, where there is no definite trace of an underground creek, have been formed in this way.

It is seldom that the visitor walks on the actual limestone bottom of the chambers or passages in the present caves, but usually on a deposit of red-earth or stalagmitic flooring, the tread in the latter case generally giving rise to considerable resonance. To display these chambers in their true size and grandeur would necessitate the removal of hundreds of tons of red earth now filling them.

VI.—Age of the Deposit.

The only means we possess of forming even the crudest idea of the age of the infilling of our caves with the red-earth as a deposit, is by means of their fossil contents—in other words, are the bones generally associated with the latter of living or extinct species? The Rev. W. B. Clarke mentioned the occurrence of bones of the Emu,* but whether of the existing or extinct species (*Dromaius patricius*, De Vis), there is no means of ascertaining. This solitary instance seems to be all that is definitely known of fossils from these caves. Mr. Jenkins has left no evidence that he collected any, although it is possible that he did, for we find the Curator of the Australian Musuem remarking†:—"I am fully convinced that no fossil bones of any value are being obtained in the Coodradigbee (*sic*) Caves." As Mr. Jenkins was recalled, just as he was about to start work at the Goodradigbee Caves, it is probable that the bones referred to were those obtained at Cave Flat, for anyone not acquainted with the district would be very liable to confound the one set with the other.

* Sedimentary Formations of N. S. Wales—Fourth Edition, 1878, p. 104.
† Exploration of the Caves and Rivers of New South Wales, &c., *loc. cit.*, p. 36.

So far as the limited time at our disposal enabled us to form an opinion, the Goodravale Caves do not contain any extended deposit of fossil bones. We had, however, the singular good fortune to unearth one of the large carnassial teeth, attached to a portion of the ramus, of *Thylacoleo*, the Marsupial Lion, in all probability *T. carnifex*, Owen. This was found under a small shelf of stalagmite, when working our way in the small passage, leading from under the large pillar in the right-hand extension of Chamber No. 5 (Pl. VIII, *h*), round towards Chamber No. 8 of the Goodradigbee Cave. The occurrence of this one genus will be quite sufficient to place the age of the red-earth deposit, at any rate its lower portions, on a par with that of the Wellington Caves, with a copious extinct fauna; the Jenolan Caves, in one of which was found the almost entire skeleton of a *Thylacinus*, a genus now quite extinct in Australia; and the Bone Cave at Cave Flat, wherein Mr. Mitchell and the Writer discovered the largest skull of *Thylacinus* known.*

* Australian Museum, Ann. Report of the Trustees for the year 1888 [1889], p. 36.

PLATE I.

Sketch plan of the Belubula Caves, by the late Mr. C. S. Wilkinson, Parish of Malongulli, Co. Bathurst.

A. Surface hole whence issues air from the cave below.

B. Large cavern about eighty feet below surface of hill.

C. "The Twins," remarkable stalagmites.

D. "Fountain Cave," containing water.

E. Circular hole in roof of the cavern.

F. Cave blocked up with masses of rock and earth.

H. Surface hole, whence issues a current of air from below.

K. Cavern, thirty-five feet high, conaining some very fine stalagmites and stalactites.

L. Thick deposit of red earth with bones.

M. Narrow passage.

N. Entrance to "Long Cave."

O. Entrance to "Bone Cave."

[Reproduced from an illustration in the Sydney *Town and Country Journal*, September 9, 1876.]

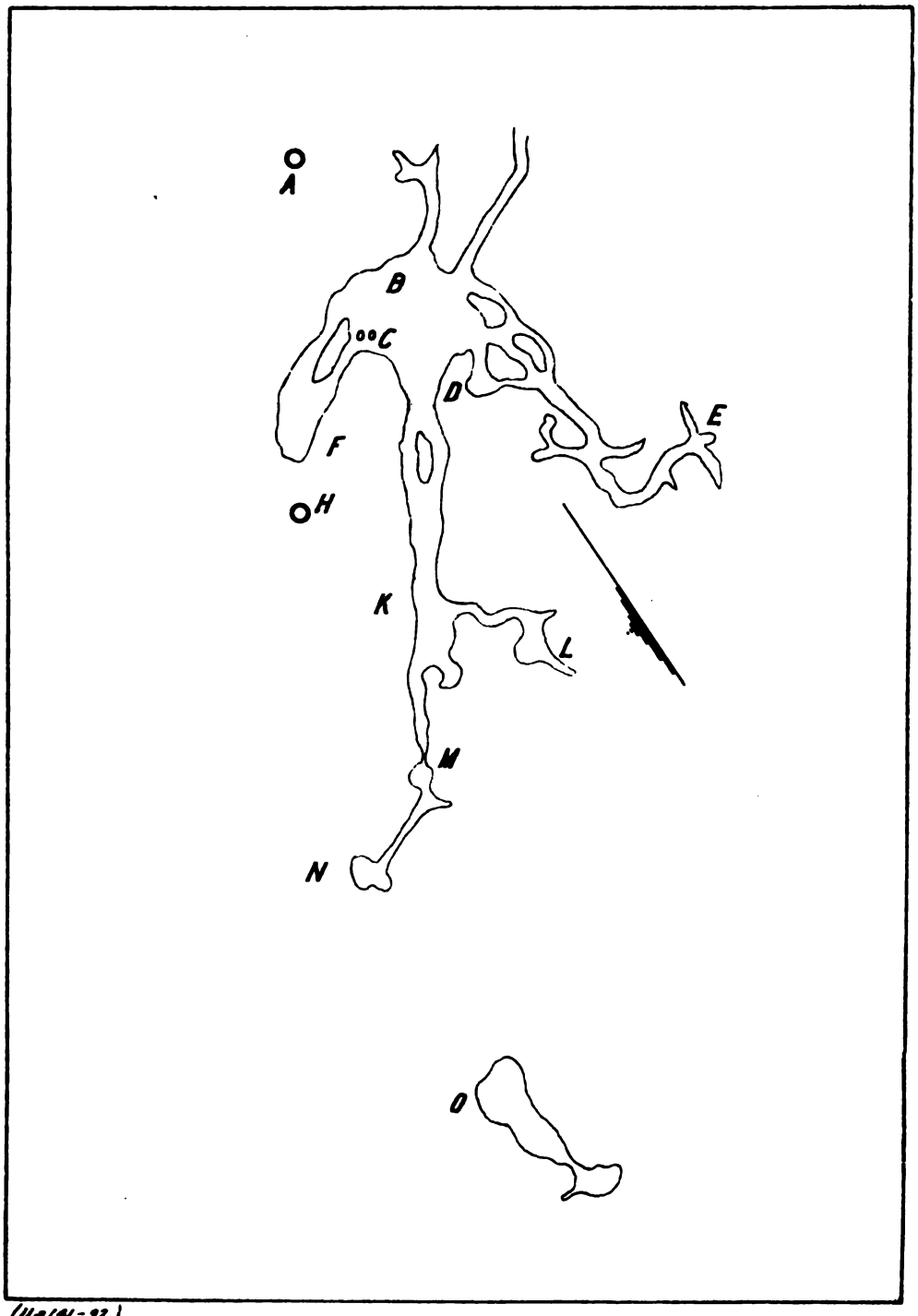


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PHOTO-LITHOGRAPHED AT THE GOVT. PRINTING OFFICE,
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PLATE II.

Stalactites overhanging two stalagmites, six feet high, Belubula Caves, Parish of Malongulli, Co. Bathurst.

[Reproduced from an illustration in the Sydney *Town and Country Journal*, September 9, 1876.]

(11a 141-92)

PHOTO-LITHOGRAPHED AT THE GOVT. PRINTING OFFICE,
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PLATE III.

Interior of Bone Cave, Belubula Caves, Parish of Malongulli, Co. Bathurst.

[Reproduced from an illustration in the Sydney *Town and Country Journal*, September 9, 1876.]

(11214-92.)

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PLATE IV.

LINGULOCARIS M'COYII, *Eth. fil.*

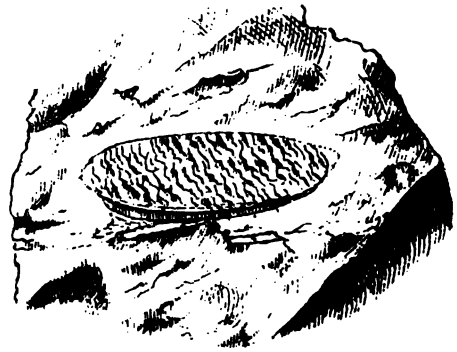
Fig. 1. Carapace, showing double ventral edge and transversely-wrinkled surface.

Fig. 2. Carapace with a longitudinally-wrinkled surface.

Fig. 3. Carapace with double ventral edge and almost smooth surface.

Fig. 4. Carapace, transversely-wrinkled, and a body lying at one end which may be an appendage.

Drawn from nature by Mr. G. H. Barrow, Australian Museum.



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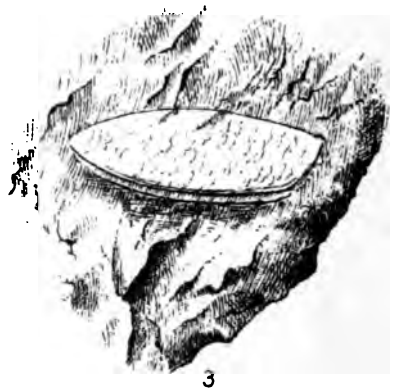

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PHOTO-LITHOGRAPHED AT THE GOVT. PRINTING OFFICE,
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PLATE V.

Plan showing the Kybean Limestone on Great Limestone Creek, and surrounding rocks.

Scale about 10 chains = 1 inch.

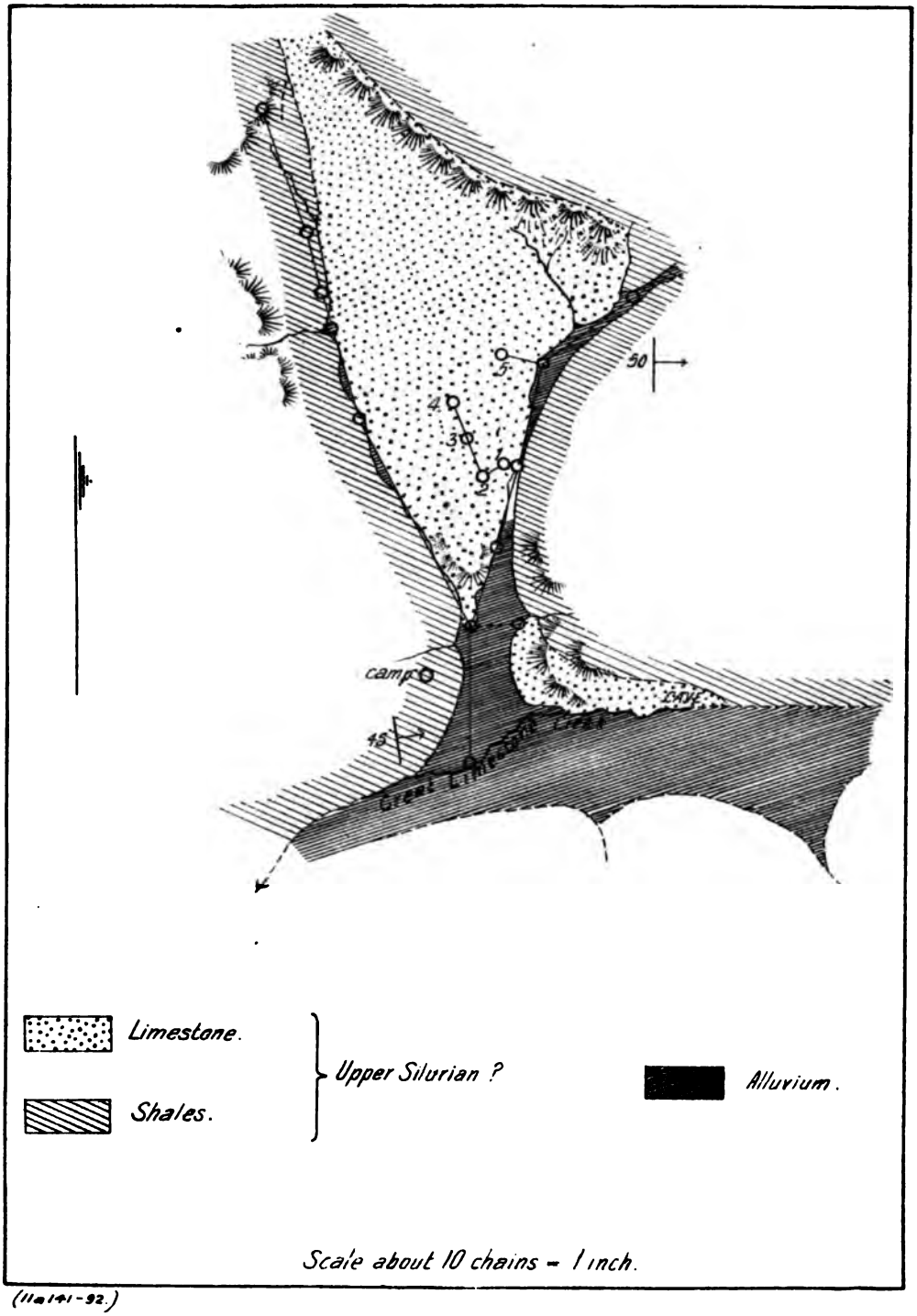

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PHOTO-LITHOGRAPHED AT THE GOVT. PRINTING OFFICE,
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PLATE VI.

Sceparnodon Ramsayi, *Owen*. (Phascolonus gigas, *Owen*.)

Fig. 1. Left upper incisor of Owen and Lydekker; Tooth, showing pit caused by abrasion.

Fig. 2. Right upper incisor of Owen and Lydekker.

Fig. 3. Left upper incisor of Owen and Lydekker, very much worn.

Fig. 4. Blunt cutting edge of ditto.

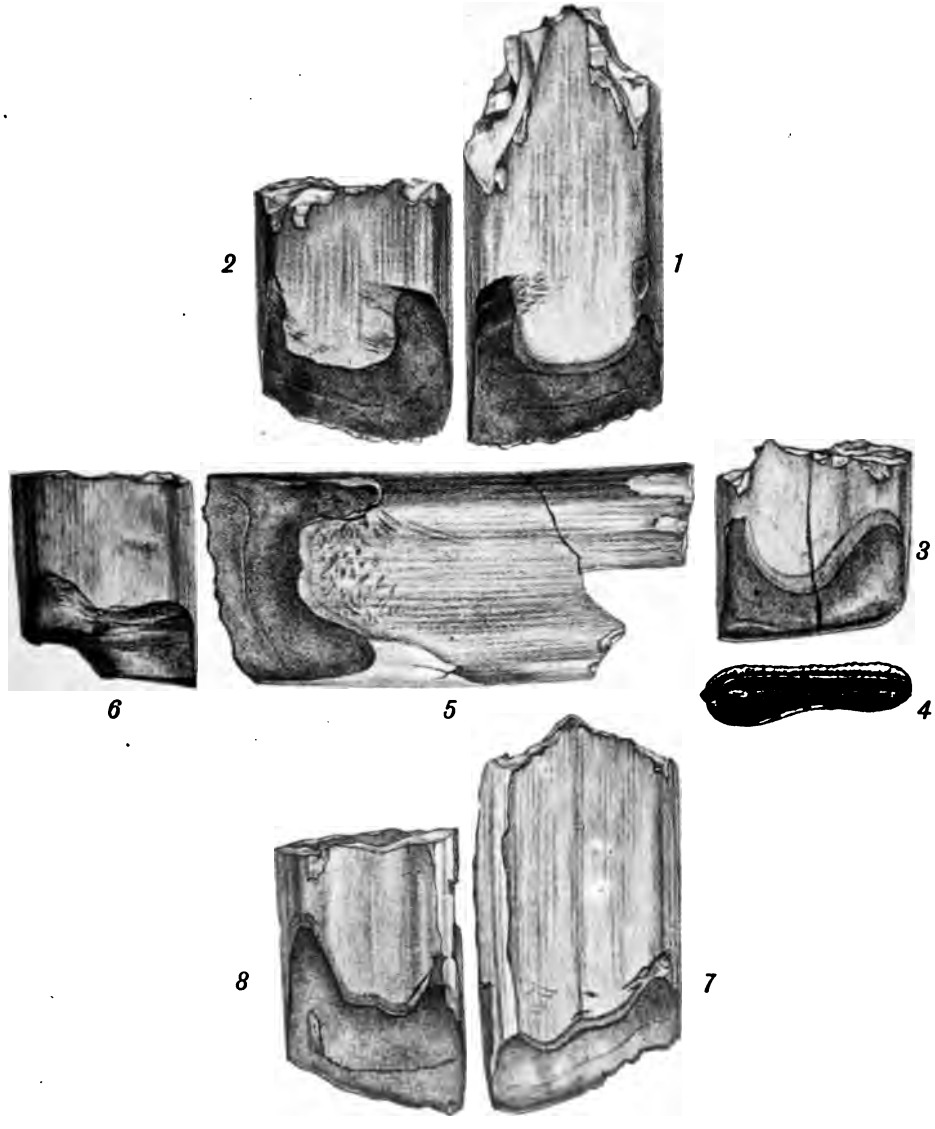
Fig. 5. Left upper incisor of Owen and Lydekker showing extensive bevelling and marks of abrasion on interior.

Fig. 6. Right upper incisor of Owen and Lydekker, of which the external corner has been broken during life; outer edge worn by contact with the corresponding lower incisor.

Fig. 7. Left upper incisor of Owen and Lydekker, showing a well marked median ridge, but no great amount of bevelling as in De Vis' lower incisor.

Fig. 8. Right ditto, ditto.

The figures drawn from nature by Mr. P. T. Hammond, are nearly three-fifths the natural size, and reversed.

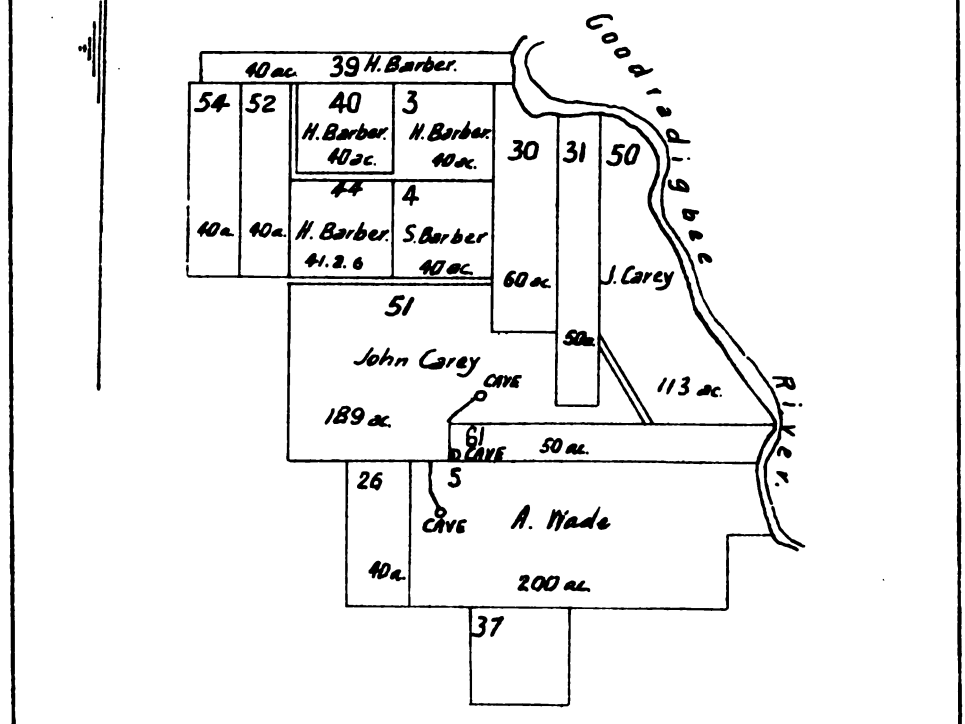


Reproduced by Heliotype.

PLATE VII.

Plan showing part of the Parish of West Goodradigbee, Co. Buccleuch, and relative positions of the Goodravale Caves.

Scales 40 chains = 1 inch.


40 ac.
39 H. Barber.
54
52
40
H. Barber.
40 ac.
3
H. Barber.
40 ac.
30
31
50
Goodradigbee
44
4
40a.
40a.
H. Barber.
41.2.6
S. Barber
40 ac.
60 ac.
J. Carey
51
John Carey
CAVE
189 ac.
50a.
113 ac.
River.
61
CAVE
50 ac.
26
5
CAVE
A. Wade
40a.
200 ac.
37

(112 141-92)

PLATE VIII.

Sketch plan of the Godradigbee Cave, Godravale, Godradigbee River, Parish of West Godradigbee, Co. Buccleuch.

Scale about 30 feet = 1 inch.

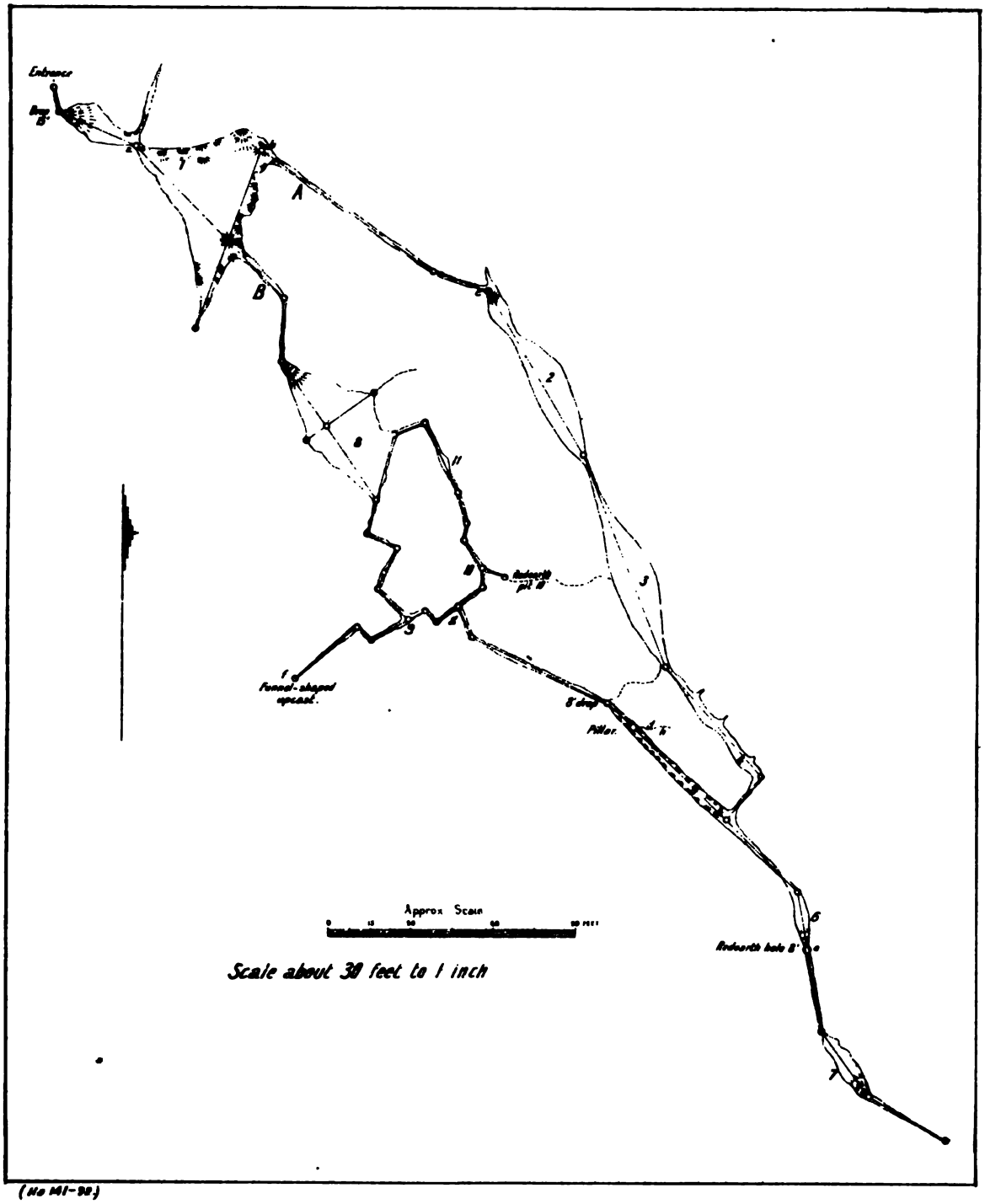


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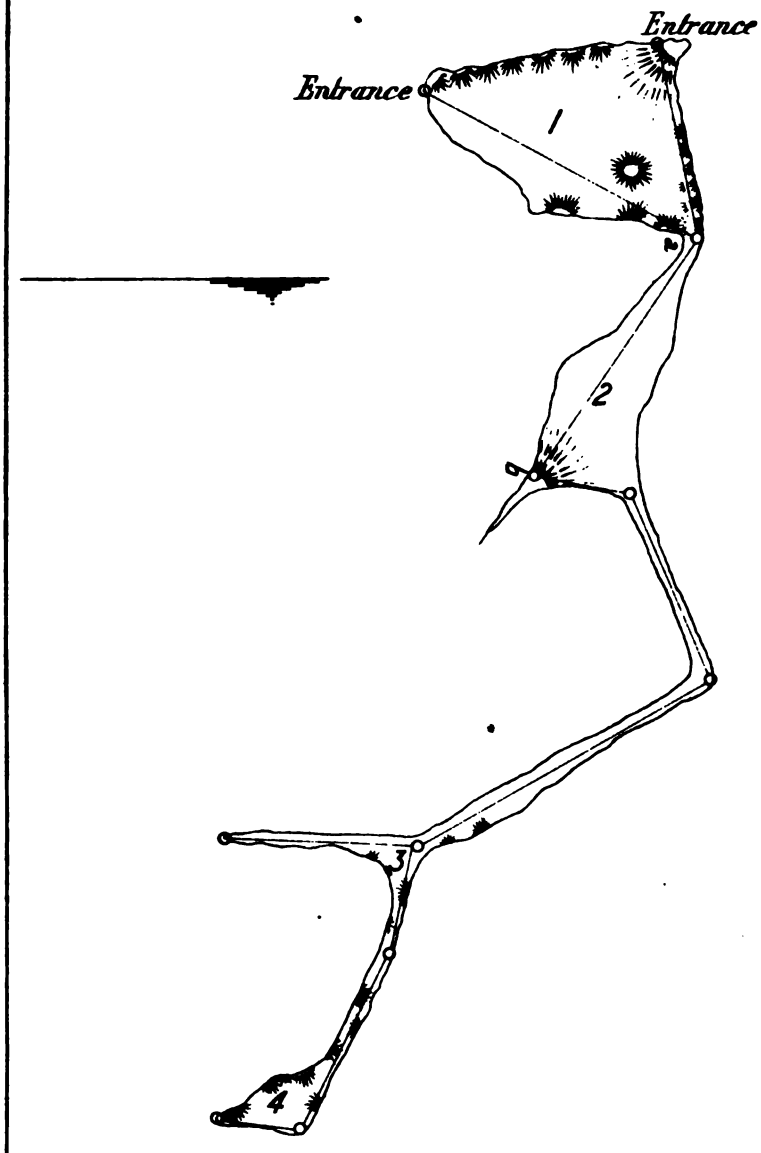
PHOTO-LITHOGRAPHED AT THE GOVT. PRINTING OFFICE, SYDNEY, NEW SOUTH WALES.

PLATE IX.

Sketch plan of the Goodravale Cave, Goodravale, Goodradigbee River, Parish of West Godradigbee, Co. Buccleuch.

Scale about 30 feet 1 inch.



Scale about 30 feet - 1 inch.

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DEPARTMENT OF MINES, SYDNEY.

RECORDS

OF THE

GEOLOGICAL SURVEY OF NEW SOUTH WALES.

Vol. III.] 1892. [Part 2.

XI.—On the Geological Occurrence of the Broken Hill Ore-deposits: by E. F. PITTMAN, A.R.S.M., Government Geologist.

DURING a recent visit to Broken Hill, I had an opportunity of inspecting the under-ground workings of several of the principal mines, and was impressed by some facts in connection with the geological occurrence of the lodes which appear to be of general interest.

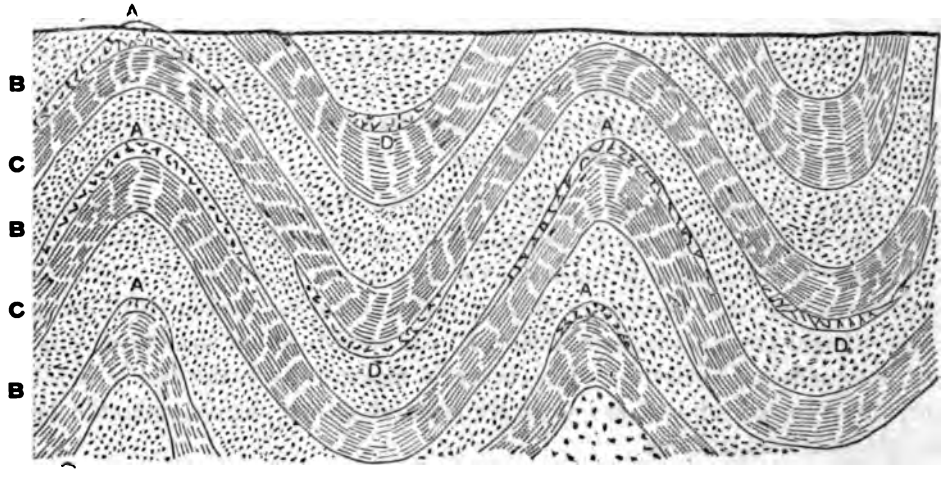
The principal impression conveyed to my mind is that the Broken Hill Ore-deposits do not occur in what is known as an ordinary true fissure lode, but should be referred to what are called "segregated lodes," of the type known in the Bendigo District (Victoria) as "saddles."

It is true that the "saddle reefs" of Bendigo (Sandhurst) differ materially from the Broken Hill Lode in dimensions, in metalliferous contents, and in the character of the gangue or veinstuff—the first named consisting of auriferous quartz with a small percentage of iron pyrites, while the Broken Hill Lode is argentiferous (though containing some gold) and consists, at and near the surface, of manganiferous ironstone, which below is replaced by kaolin and oxidised ores (carbonates) of lead, and these are again, at greater depths, succeeded by sulphides of lead and zinc.

Nevertheless, there are points of similarity between the two which are worthy of note, and which may have some bearing upon the probable persistence in depth of the Broken Hill Ore-deposits.

The difference (according to J. A. Phillips) between a true fissure vein and a segregated vein consists in the fact that the former occupies a fissure, cutting (in a direction which may be more or less oblique) across the bedding planes of the country rock, while the latter is deposited in a fissure formed between and parallel with the stratified beds; the ore, in fact, having filled the space caused by the forcing apart of two contiguous beds. The variety of segregated veins, so well known in Bendigo, as "saddle reefs," and which, so far as I know, have not been hitherto recorded as occurring in any mining country except Victoria, differs from ordinary segregated lodes, merely in the fact that instead of lying in one plane, they occupy spaces or fissures which, owing to the bending or contortions of the country rocks, have assumed somewhat the shape of an inverted trough, and in cross section have the appearance of a saddle—hence the name.

The country rock at Bendigo consists of highly contorted slates and sandstones which are of Lower Silurian age. The contortions of these slates and sandstones have assumed the forms of anticlines and synclines. If a quire of paper be placed flat upon a table and lateral pressure be exerted against the sides, it will be found to form saddles and troughs, or anticlines and synclines, corresponding with the contortions of the Bendigo rocks, which have in fact been produced in an analogous manner, and it will be noticed that spaces will be formed between the sheets of paper, more particularly at the upper parts of the anticlines and the lower parts of the synclines, corresponding exactly with the fissures in which the saddle reefs of Bendigo were deposited.

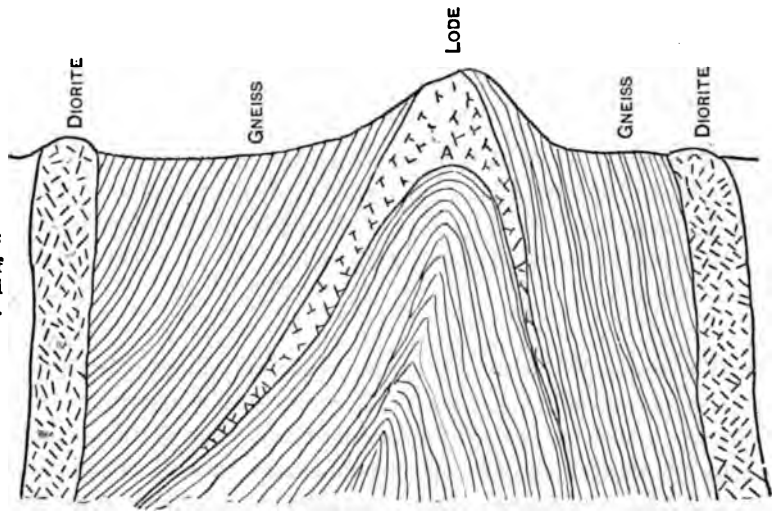


A—Saddle reefs. B—Sandstone. C—Slate. D—Inverted saddles.

The reefs at Bendigo are associated with narrow intrusive dykes of dark grey dolerite, which probably have had some influence upon their auriferous contents.

One of the chief points of interest about the saddle reefs of Bendigo is, that while the "legs" of the saddles are invariably found to thin out and disappear in depth, the permanence of the mines is assured by the certainty of other saddles being discovered almost perpendicularly under the first, and at greater or less intervals of depth.

Now the Broken Hill District is composed of similarly contorted rocks, consisting principally of crystalline gneisses passing into banded quartzites, micaceous and hornblendic schists, and garnetiferous sandstones. Owing to the highly altered character of these rocks, and the consequent absence of organic remains, it is difficult to determine their exact age, but they were considered by the late Mr. C. S. Wilkinson, F.G.S., to be at least as old as Lower Silurian, and probably older. There are no dolerites in the neighbourhood of the mines, but intrusive dykes of highly basic diorite are seen extending along both sides of the hill and more or less parallel to it. Broken Hill itself is composed of an anticline, the highest part of the ridge being occupied by the outcrop of the lode—a mass of manganiferous iron ore which has withstood denudation by reason of its hardness and compactness—while on the eastern and western slopes of the hill the gneissic rocks are found to be dipping east and west respectively. Below in the mines the lode is found to divide into two portions, one following the eastern dip, while the other and larger portion dips to the west. The depth at which the lode divides differs in the different lodes along the hill. The rock which separates or divides the lode into the eastern and western portions is locally referred to by some as the "horse," and by others as the "intrusion," but it appears to me that both terms are incorrect and misleading. It is not an intrusion, because it has not the character of a volcanic or intrusive rock, but consists in some places of gneiss, and in others of banded quartzite, both similar in character to the rocks to be seen at the surface. A "horse" consists of a mass (of greater or less extent) of country rock which has fallen from the hanging wall into the vein fissure before the latter was filled with mineral. But the character of the rock forming the so-called "horse" at Broken Hill shows that it has not fallen into the fissure, and been subsequently surrounded by lodestuff, but that it is the country rock or footwall of the lode *in situ*. In short, the foliations of this rock, which appear to coincide with its bedding planes, are clearly defined, and appear to indicate that it is the cap of an anticline, forming the lower walls of a saddle-shaped fissure which the lode has filled, and similar in formation to the curved beds of slate and sandstone which separate the legs of the saddle reefs at Bendigo.



Ideal Section of Broken Hill.

It has already been stated that this so-called "intrusion" is found at materially different depths in the principal mines along Broken Hill, and herein is another point of similarity to the Bendigo saddle reefs, which rise near to the surface in some mines and descend to greater depths in others, owing to the fact that the country rocks in which the reefs occur are contorted into curves along their line of strike as well as in the transverse direction.

The Broken Hill Lode, in short, appears to be a huge saddle lode, formed in a fissure which owed its shape to the contortions which the gneissic rocks have undergone. If this opinion be correct, the probability is that the eastern and western legs will be found to thin out gradually as they descend, and in that case the depth at which they would disappear would depend to a great extent upon the width of the synclinal basins on either side of the hill. The underground workings in Block 10 show that at a depth of over six hundred feet the western leg is still represented by a huge width of sulphide ores, so that the possibility of the lode thinning out is evidently not a matter for immediate alarm. What appears, however, to be the most interesting question is the possibility of similarly shaped lodes being found more or less vertically under the present one, as they are found to occur in Bendigo, and undoubtedly the best means of ascertaining this would be to put down diamond drill bores through the cap of the so-called intrusion.

The conclusions which I have endeavoured to convey, and in forming which I was assisted by the work already performed by Mr. Geological Surveyor Jaquet, may be summarised as follows :—

(1) In several important respects the geological formation and origin of the Broken Hill Lode and the saddle reefs of Bendigo appear to be analogous.

(2) If this analogy hold, the eastern and western legs of the Broken Hill Lode may be expected to thin out in depth.

(3) There is a possibility of other similarly shaped lodes being found more or less vertically underneath the Broken Hill Lode, and this could best be tested by putting down diamond drill bores through the cap of what is locally known as the "intrusion."

XII.—The Pentameridæ of New South Wales: by R. ETHERIDGE, Junr., Palæontologist and Librarian.

[Plates X and XI.]

I.—Introduction.

THE protean genus *Pentamerus* is represented in the Siluro-Devonian rocks of New South Wales, by six species, as follows:—

Pentamerus australis, *McCoy.*
„ Knightii, *J. Sby.*
„ linguifer, *var.* Wilkinsoni, *Eth. fil.*
„ ? costatus, *Eth. fil.*
„ hospes, *Barrande.*
„ pumilus, *De Kon.*

In the Upper Silurian of Victoria by one species—
Pentamerus australis, *McCoy.*

In beds of a similar age in Tasmania *apparently* by three species—
Pentamerus Knightii, *J. Sby.*
„ galeatus, *Dalman.*
„ tasmaniensis, *Eth. fil.*

The Middle Devonian of Queensland contains one species—
Pentamerus brevirostris, *Phill.*

Of these, by far the most interesting is *Pentamerus Knightii*, or at any rate the form which has been assumed to represent that species. It is as equally characteristic of a well-marked calcareous horizon in our Siluro-Devonian rocks as it is of the Aymestry Limestone in the British Upper Silurian. The shell affords an admirable key to this horizon at many wide-spread localities, as, for instance, at the Fish River, or Jenolan caves; Yarrangobilly Caves, near Kiandra; Goodravale

Caves, Goodradigbee River; Forest Reefs, near Orange; Bungonia Caves, Shoalhaven District; and Quedong, near Bombala, at most of which it occurs in abundance, and often of very large size.

II.—History.

In 1867 Professor Sir F. McCoy named*, and in 1878 described † his *Pentamerus australis* from the Upper Silurian of the Parish of Yerring, Upper Yarra, Victoria, which appertains to the group of *P. oblongus*, J. de C. Sby., and probably represents the latter in Australian rocks.

In 1882 I described a peculiar form of the genus from the Tasmanian North-west Coast Conglomerates,* and on a portion of which, as a basement bed, the well-known Tertiary beds of Table Cape repose. To this shell, a small but definite ally of *P. Knightii* also, I gave the name of *P. tasmaniensis*.

The late Prof. de Koninck referred two *Pentameri* in the Rev. W. B. Clarke's Collection to the European *P. Knightii*, J. Sby., and *P. oblongus* J. de C. Sby.,† from the Conobolas and Duntroon, New South Wales, respectively; and he further named a third species from Yass, believed to possess Devonian affinities, as *P. pumilus*. The so-called *P. oblongus*, is quoted by Mr. Charles Jenkins, L.S., from his Hume division of the Yass Upper Silurian; ‡ and by Mr. John Mitchell from Limestone Creek, near Bowning,§ in beds of a similar horizon. It is more than probable that the shell referred to by Mr. Jenkins, and certainly Mr. Mitchell's, is the *Pentamerus australis*, M'Coy. Mr. Mitchell also mentions ‖ another shell, a "deeply corrugated *Pentamerus* of triangular shape, that I have not yet identified, and which appears to be typical of this zone." This is referred later on to *P. hospes*, Barr.; whilst Mr. R. M. Johnston's *P. Knightii*,¶ from the Brachiopod Sandstone of the Queen River, Tasmania, and his *Pentamerus galeatus*** from the same horizon, have every appearance of being those species. Lastly, I have described†† from Queensland a well-marked Devonian *Pentamerus*, viz., *P. brevirostris*, Phillips, from the Fanning Limestone, Burdekin Downs.

This completes the published record of our Australian *Pentameri*. To them, however, must be added a very interesting form, to which my attention was first directed by Mr. Mitchell, his specimens being afterwards supplemented by others collected by us at Goodravale, Goodradigbee River, and now termed *P.? costatus*.

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* Ann. Mag. Nat. Hist., 1867, XX., p. 201.
† Prod. Pal. Vict., Dec. v., 1878, p. 28, t. 47, f. 9-12.
* Proc. R. Soc. Tasmania for 1882 [1883], p. 159.
† Foss. Pal.-Nouv.-Galles du Sud, Pt. 1, 1876, p. p., 30, 31, and 94.
‡ Proc. Linn. Soc. N. S. Wales, 1878, III, Pt. 1, p. 26, t. 6, f. 3.
§ Proc. Linn. Soc. N. S. Wales, 1887, I (2), Pt. 4, p. 1198.
‖ *Loc. cit.*, p. 1198.
¶ Syst. Acc. Geol. Tasmania, 1888, t. 7, f. 10.
** Syst. Acc. Geol. Tasmania, 1888, t. 7, f. 10*a*.
†† Geol. and Pal. Queensland and New Guinea, 1892, I, p. 67, t. 37, f. 6, 9-11.

I have omitted from consideration the *Pentamerus oblongus*, said by the late Rev. J. E. T. Woods,* to have been found years ago in the Mount Lofty Chain, thirty miles south of Adelaide, as it requires confirmation.

III.—Notes on, and Description of the Species.

Genus.—PENTAMERUS, *J. Sowerby*, 1813.

(Min. Con., I, p. 73*).

Pentamerus australis, M'Coy.

Pentamerus australis, M'Coy, Prod. Pal. Vict., Dec. V., 1877, p. 28, t. 47, f. 9–12.
? „ *oblongus*, Jenkins (*non* J. de C. Sby.), Proc. Linn. Soc. N. S. Wales, 1878, III, Pt. I, p. 26, t. 6, f. 3.
„ „ Mitchell, *Ibid*, 1887, I (2), Pt. 4., p. 1198.
„ „ Mitchell, Proc. Austr. Assoc. Adv. Sci., 1888, I, p. 294.

Obs.—P. australis may be looked upon as an Australian representative of the European and American *P. oblongus* . . . . which it strongly resembles in size, shape, and surface. It is, however, perfectly distinguished by the inarching of the septa of the entering valve, and the large ovate rostral space so defined in the casts (*M'Coy*).

Both Messrs. Jenkins and Mitchell, as before noticed, have recorded the occurrence of a *Pentamerus* in the Bowning beds, referred by them to the European *P. oblongus*.

As regards Jenkins' shell, the figure is not sufficiently complete to allow a definite opinion to be formed, but it seems to be M'Coy's species. The shells, provisionally named *P. oblongus*, by Mr. Mitchell, I have seen, thanks to his kindness, and these are, in my opinion, nothing more than *P. australis*, M'Coy, from the May Hill Sandstone, of Yering, Upper Yarra District, Victoria. They possess the same longitudinally ovate and slightly convex form, with the surface unornamented, except by a few concentric undulations. On the other hand, the New South Wales examples are certainly smaller than the Victorian. In passing, a comparison may be instituted with *Pentamerus Knappi*, Hall*, but this will be found to be radiately costate in the centre of the valves. I have not seen the shell from Duntroon, named *P. oblongus*, by De Koninck,† and therefore refrain from including it in the above synonomy, but I suspect that it will prove to be *P. australis*, M'Coy.

* Geol. Obs. S. Australia, 1862, p. 20.
† Foss. Pal. Nouv.-Galles du Sud, Pt. I, 1877, p. 31.

It is difficult to understand from Mr. Jenkins' remarks to what portion of his "Hume" Series this species belongs; but in the corresponding "Bowning" Series of Mitchell, it is clearly met with in the lower portion of his Lower Limestone, at the base of the "Bowning Series."

Loc. and Horizon.—Silverdale, Limestone Creek, near Bowning (*J. Mitchell*); lower part of the Lower Limestone of "Bowning" (Hume) beds. Yass River, near junction with Boonu Ponds, near Yass (*C. Jenkins*); the fifth division of the "Hume" beds.

PENTAMERUS LINGUIFER, *J. de C. Sby.*

P. linguifer, var. Wilkinsoni, *var. nov.*

Pl. XI, Figs 5–9.

Pentamerus galeatus, Mitchell (*non* Dalman), Proc. Linn. Soc. N. S. Wales, 1887, I (2), Pt. 4., p. 1203.

" " Mitchell. Proc. Aust. Assoc. Adv. Sci., 1888, I, p. 294.

Sp. char.—Shell sub-globose, usually inflated, and as a rule wider than long. Ventral valve much curved, depressed above and thickened about the umbonal region; sinus very shallow, wide, flattened, and bounded on each side by a slightly raised fold; front deflected, produced, sometimes becoming almost perpendicular to the longer axis; lateral portions of the valves broadly rounded; umbo incurved, the sulcus commencing as a very shallow, almost imperceptible groove quite from the apex; vascular system (on internal casts) possessing two main trunks, arising in the umbonal cavity, and shortly bifurcating, with a lateral branch proceeding down each flank and central branches on either side of the shallow sinus, each portion again dividing near the front; septum comparatively short. Dorsal valve transversely ovate, wider than long; tripartite subdivision frequently highly marked, arising from a strong development of the mesial fold, which is confined to the anterior half of the valve, impressed by a faint median groove, and, when seen from the front, squarish; when viewed in profile the valve is convex from the umbo until the fold commences to rise, whence it is concave to the front margin; front margin sinuated, the central emargination rather straight-sided. Surface of the valves with a few laminæ of growth, otherwise smooth.

Obs.—I first became acquainted with this interesting variety many years ago, in a small collection of fossils sent to me for identification by my late friend Mr. C. S. Wilkinson, Government Geologist, and then regarded it as *P. linguifer*. It resembles both *P. linguifer*, J. de C. Sby., and *P. globosus*, Barr., and in a less degree *P. galeatus*. Like *P. globosus*, Barr.*, our species possesses two plications on the ventral valve, and a flat sulcus between them, but they are absent on the

* Syst. Sil. Bohême, 1879, V, t. 24, f. vi.

dorsal valve, and thereby differ from Barrande's species. The plications are replaced in our shell by the ordinary rounded folds of the dorsal valve. The septum is also much smaller. On the exterior of the dorsal valve only one septum is visible; but, that this will not invalidate the reference to *Pentamerus* is shown by the occurrence of the same feature in Dr. Davidson's figure of *P. linguifer*†, and Barrande's *P. optatus*.‡ Some specimens of our shell, again, are not unlike *P. pelagicus*, Barr§.

I do not trace any great resemblance to *P. galeatus*, Dalman, the high umbo of the ventral valve, and semi-costate nature of the surface of this species separating it from *P. linguifer*, var *Wilkinsoni*. On the other hand, there is a close relation between the latter and *P. linguifer*, J. de C. Sby**, even to the flattened or depressed umbo of the ventral valve, but the appearance of the fold and sinus in the two differs considerably and may be used for varietal separation. For a long time I hesitated whether to consider the Australian shell as a variety of *P. linguifer*, or a separate species. On the whole, it seems to be intermediate between *P. linguifer*, J. de C. Sby, and *P. globosus*, Barr., and to represent the two species in Australia, just as *P. australis*, M'Coy, does the shells of the *P. oblongus* group. *Pentamerus subglobosus*, Meek and Worthen††, has a similar inflation of the front to the var. *Wilkinsoni*, but the valves are otherwise comparatively smooth. *P. fornicatus*, Hall‡‡, is also rather like the latter, but is, judging from the figures, too deltoid a form.

The square-fronted straight-sided fold and sinus, seen in so many examples of *P. linguifer* var. *Wilkinsoni*, is exhibited by Davidson's Fig. 11*b*§§; the depressed umbo of the Australian variety is visible in his Fig. 11; whilst the general form of the ventral valve of the new variety is displayed in Fig. 13*b*, of the same author. There are occasional instances, however, in which the inflated round-shouldered appearance presented by Davidson's Fig. 11*a* is visible amongst our specimens. In short, *P. linguifer*, var *Wilkinsoni*, exhibits the same amount of variation *inter se* that the species in chief does, and on the same lines; but it differs from the latter in its peculiarly flattened ventral sulcus, and other minor characters. As before said it seems to occupy an intermediate position between *P. linguifer*, and *P. globosus*.

Through the kindness of Mr. John Mitchell, I have examined the *Pentameri* obtained by him from the various beds of his Bowning Series, as indicated in the synonomy, and I find the form recorded by him as *P. galeatus* from the lower

† Mon. Brit. Sil. Brach., 1867, Pt. VII, No. 2, t. 17, f. 11 and 13.
‡ *Loc. cit.* t. 24, f. v. (5c., 6c. and e.)
§ *Loc cit.*, t. 23.
** Davidson, Mon. Sil. Brach., 1867, Pt. VII, No. 2, p. 149, t. 17, f. 11-14.
†† Illinois Geol. Report, III, p. 428, t. 13, f. 6*a*.
‡‡ Pal. N. York, 1852, II, p. 81, t. 24, f. 7 *a-d*.
§§ *Loc. cit* t. 17.

portion of his Lower Limestone to be the present variety, an identification in which Mr. Mitchell now coincides. The same remark applies also to the *Pentamerus* recorded by him from his Lower Trilobite bed. This is the upward limit of *P. linguifer*, var. *Wilkinsoni*, according to Mr. Mitchell's section; and in all probability it will coincide with the horizon given in Prof. T. W. E. David's section of the Yass Upper Silurian, extending from the Bald Hill Creek to the Reedy Creek*, although a thorough unanimity does not appear to exist in the sequence of the beds as laid down by the authors in question. According to Prof. David, a *Pentamerus* occurs at Hatton's Corner, Yass River, in dark greenish brown shales, "possibly a continuation of the shale beds at Limestone Creek, which yield fine specimens of *Phacops caudatus*, and *Phacops longicaudatus*." This *Pentamerus*, from specimens at present before me, is *P. linguifer*, var. *Wilkinsoni*; the shale so rich in Trilobites is probably the "Phacops bed" of Mr. Chas. Jenkins†, and the Middle Trilobite bed of Mr. Mitchell, but, according to the notes obligingly supplied by the latter, the particular shells in question come from his Lower Trilobite bed, hence the discrepancy.

Loc. and Horizon.—Junction of Limestone and Barbour's Creeks, near Bowning (*J. Mitchell*); Lower Limestone, Bowning Series. Limestone Creek, near Bowning (*J. Mitchell, T. Ramft*); Lower Trilobite bed, Bowning Series (*Mitchell*). Hatton's Corner, Yass River (*J. Mitchell*); Lower Trilobite bed, Hume Series,‡ Quedong, Delegate River, three miles below junction with Bombala River, County Wellesley (*C. Cullen*); horizon undetermined.

I regard the Bowning horizon as portions of the Wenlock Formation, and, by analogy, those at Quedong containing this species will probably be of the same age.

PENTAMERUS KNIGHTII, *J. Sowerby.*

Pl. X, Figs. 1-6; Pl. XI, Figs. 1-4.

Pentamerus Knightii (J. Sby.), Davidson, Mon. Brit. Sil. Brach., 1867, Pt. vii, No. 2, p. 142, t. 16, f. 1–3, t. 17, f. 1–10, t. 19, f. 3.

" " De Koninck, Foss. Pal. Nouv.-Galles du Sud, 1876, Pt. 1, p. 30,

Very large Pentamerus, Mitchell, Proc. Linn. Soc. N.S. Wales, 1888, I (2), Pt. 4, p. 1198.

Pentamerus Knightii, Johnston, Syst. Acc. Geol. Tasmania, 1888, t. 7, f. 10.

Sp. Char.—Shell elongately triangular, both valves much arched longitudinally, extending towards the front, becoming more or less geniculate, especially the dorsal valve, and the surfaces of both evenly convex. Ventral valve narrow and

* Ann. Report Dept. Mines N.S.Wales for 1882 [1883], Sections 1 and 3.
† Proc. Linn. Soc. N.S. Wales, 1878, III, pt. 1, p. 25.
‡ Hume Series of Jenkins—Bowning Series of Mitchell.

laterally compressed in the visceral region, expanding towards the front, the frontal margin being very sinuous, convex at the sides, emarginate in the middle; umbo pointed, much incurved, and overhanging a high and narrow sub-umbonal space, or false area; fissure long, not wide, and generally much exposed; septum very long, extending almost to the front margin, and almost vertically truncated, its double laminæ thick, and, when separated, the transverse, curved, sub-imbricating growth ridges well marked; divergence of the dental plates slight, growth ridges on them sigmoidally curved; middle or V-shaped chamber narrow. Dorsal valve short, broadly triangular, generally very much smaller than the ventral, and frequently displaying a considerable amount of geniculation; umbo not prominent, but deeply inserted in the fissure; lateral margin emarginate, front margin convex, but no perceptible trace of a fold; hinge plates very long, extending nearly to the front. Surface of both valves with numerous simple or furcate costæ, except to a large extent on the flanks of the ventral valve, and slightly so on those of the dorsal, where the costæ are absent and the flanks smooth, except a few wide undulations of growth, which cross the valves generally.

Obs. The foregoing description has been wholly drawn up from Australian specimens, and will enable a critical comparison to be made with the European forms of the species. Our variety of *P. Knightii* acquired large dimensions, although the average size is two inches long, and at the front of the valves one and a half inches wide. In the caverns of the Yarrangobilly, and Goodravale Caves, I have seen natural sections of the shell four and five inches long, which is quite equal to the largest examples of *P. Knightii*, of the Aymestry Limestone, in the West of England.

No more characteristic species occurs in our "Siluro-Devonian" Limestones than *P. Knightii*, as evinced by the twelve localities given below, and I am in the belief that it chiefly characterises a certain horizon.

From a morphological point of view, the most valuable point of difference between the European and Australian forms of *P. Knightii* lies in the further forward extension in the latter of the ventral septum, and the septa of the dorsal valve, features which impress themselves most strongly on the observer when viewing natural sections of the valves on rock surfaces, as at the Goodravale and other caves.

It is worthy of remark that our form appears to differ in precisely the same manner amongst its own individuals as the European does; for instance, some occur (Pl. X, Figs. 2 & 4) with the flanks, particularly of the ventral valve, devoid of costæ, precisely similar to Dr. Davidson's Pl. 17, f. 1a. The latter figure also shows the high, outstanding, although incurved umbo, which compares well with that shown in our Pl. X, Figs. 1, 2, & 4. In other cases the umbo is much more depressed.

We also possess the oval variety represented by Davidson in his Pl. 17, Fig. 5, and the transverse form (Davidson, Pl. 17, Fig. 4) is a most marked one in New South Wales, especially at Quedong, where nearly the whole of the specimens are of this shape. Variation also takes place in the costation, small individuals, and probably also young forms, possessing very much finer and comparatively close set costæ (Pl. X. Figs. 5 and 6.)

The valves of our *P. Knightii* are at times very geniculate, more so than any figured by Dr. Davidson, so much so on the part of the dorsal valve, that the latter does not wholly face its fellow ventral, but partially only; and the line of union of the two valves is not parallel to the longer axis, but to a greater extent transverse to it. This will be manifest on examining Pl. X. Fig. 4.

The late Dr. Davidson seemed to think *that very little difference existed between *P. Knightii*, J. Sby, and *P. vogulicus*, V. and K.† Outwardly the resemblance is a very close one, but the growth ridges on the septum of *P. vogulicus* run directly across it, and are not at all sigmoidal as in *P. Knightii*. On the other hand the ridges on the dental plates of *P. vogulicus* are gently sigmoidal. The structure is confirmed by the figures of the Russian species given by Mr. Von Gruenewaldt in his "Fossils of the Silurian Limestone of Bogosslowsk."‡ In our species the structure of these plates is as in *P. Knightii*.

Again, so far as external appearances are concerned, a very close resemblance exists between the Australian *P. Knightii* and *P. conchidium*, Dalman, as figured from Cornwallis Island, Arctic Regions, by Salter.§ But the striation in the latter more nearly resembles that of *P. vogulicus*, and it is the type of a section of *Pentamerus* only, characterised by a small deltidium, but of which there is no trace in our form.

As *P. Knightii* possesses with us great stratigraphical importance, it will be necessary to closely investigate the various horizons at which it has been found; suffice it to say, at present, that it does not seem to have been noticed by Jenkins in his Yass or Hume beds, but Mitchell mentions a "very large *Pentamerus*" on the horizon of *Euomphalus Clarkei*, De Kon, in the upper part of the Lower Limestone. This is *P. Knightii*.

In the typical Upper Silurian area of Wales and Western England, *Pentamerus Knightii* is the characteristic fossil of the Aymestry (or Ludlow) Limestone, although it occurs sparingly in the underlying Wenlock, and overlying Upper Ludlow, but not sufficiently to become a distinctive fossil of either series. It would appear,

* Mon. Brit. Sil. Brach., 1867, Pt. VII, No. 2, p. 144.
† Géol. Russie d'Europe, 1845, II, t. 7, f. 2, *b*.
‡ Mém. Sav. Étranges, St. Petersbourg, 1854, VII, t. 4 (separate copy), f. 14 *d*.
§ Sutherland's Journal Voy. Baffin's Bay and Barrow Strait, 1852, II, App., p. ccxxv, t. 5, f. 9 and 10.

therefore, that we also possess limestones equally characterised by *P. Knightii;* and it will be interesting to ascertain whether or no such deposits occupy a homotaxial position to that of the Aymestry Limestone in the Silurian Series of Europe. In the meantime, I purpose calling the beds in which *P. Knightii* predominates with us the Pentamerus Limestones.

Localities.—Jenolan or Fish River Caves, near Oberon, Co. Westmoreland (*T. W. E. David*, B.A. &c.); Bungonia Caves, near Marulan, Co. Argyle (*L. Guymer*); Forest Reefs, near Orange, Co. Bathurst (*E. O'Shea*); Walli, fifteen miles from Cowra, Co. Bathurst (*G. S. Evans*); Kerr's Creek, Calloola Mts., Co. Bathurst, (*Australian Museum*); Limestone Creek, near Bowning, Co. Harden; (*J. Mitchell, T. Ramft*); Goodravale Caves, Goodradigbee River, Co. Buccleuch (*R. Etheridge, Jun.* and *J. Mitcheil*); Yarrangobilly Caves, near Kiandra, (*W. S. Leigh, R. Etheridge, Jun., V. Wiburd*); Biddenluke, Co. Wellesley; Quedong, Delegate River, three miles below junction with Bombala River, Co. Wellesley (*C. Cullen*); Mount Canobolas, Co. Bathurst (*L. G. de Koninck*); Calalamine (*L. G. de Koninck.*)*

PENTAMERUS HOSPES, *Barrande.*

Pl. XI, Figs. 11 and 12.

Pentamerus hospes, Barrande, Syst. Sil. Bohême, 1879, V., t. 20, f. 11 *a-g*, t. 24, f. VIII, *a-b*.

Obs.—Imperfect examples of a *Pentamerus*, collected by Mr. J. Mitchell in the Bowning District, are clearly allied to three Bohemian species—*P. hospes*, Barr., *P. sulcifer*†, Barr., *P. firmus*, Barr.‡, but more particularly to the first named.

P. hospes is a triangular shell, the two others rather less so; all strongly arched longitudinally, particularly the ventral valves, and bearing sharply angular, coarse, regular, simple, radiating costæ. The Bowning examples also indicate a very triangular convex-valved shell, bearing similar costæ, but these seem to bifurcate here and there. The greatest affinity appears to exist with *P. hospes*, and I shall content myself by referring the Bowning specimens to that species, provisionally, until we are better acquainted with their more complete structure.

Of the five specimens in existence four seem to be the ventral valve, and the remaining one the dorsal. The outline of the ventral valve is strongly triangular, with the flanks either vertical or concave, as in *P. Knightii*. The costæ vary from six to ten in number, and are strong, angular, and complete as a rule, but in two instances they are seen to bifurcate. The interspaces or valleys are deep and open. There are traces on one specimen of concentric, sub-imbricating, moderately close laminæ.

* I am unable to trace this locality, unless it be Coolalamine Plain, locally called "Coolaman," between the Goodradigbee and Cotter Rivers, Co. Cowley, mentioned by Clarke (S. Goldfields, 1860, pp. 80 and 104.)
† Syst. Sil. Bohême, 1879, V., t. 9, f. vii, *a.c.*
‡ Syst. Sil. Bohême, 1879, V., t. 9, f. viii, *a.c.*; Ibid., t. 79, f. ii, *a.b.f.h.*

The dorsal valve appears to be less triangular and broader, as is often the case in the genus *Pentamerus*.

The ventral septum extends for about one-third the length of the valve exteriorly, whilst the dorsal septa are rather shorter.

The resemblance to *P. hospes* is increased by the presence in the latter of close concentric laminæ similar to those visible on one of our specimens. Next to *P. hospes* the latter resemble *P. sulcifer* rather than they do *P. firmus*.

Loc. and Horizon.—Junction of Barbour's and Limestone Creeks, near Bowning (*J. Mitchell*); Lower Limestone (Wenlock) of the Bowning Series.

PENTAMERUS? COSTATUS.—*Sp. nov.*

Pl. X, Figs. 7 and 8, Pl. XI, Fig. 10.

Sp. chars.—Shell small, longitudinally oval. Ventral valve longitudinally arched, high in the umbonal region; umbo acute, rather incurved; false area high and triangular; fissure large, extending from immediately under the umbo-apex to the hinge line; the latter shorter than the width of the shell, with well rounded alar angles; sinus very well marked, deep, channelling the umbo to the very apex; front margin deeply emarginate in the middle line; dental plates short; V-shaped, or central chamber, small; costæ strong and simple, two prominent ones bounding the sinus, followed by two or three more on each side.

Obs.—For this interesting form we are indebted in the first instance to the careful researches of Mr. John Mitchell, who collected examples some years ago at Goodravale, Goodradigbee River. During a recent visit to that locality we mutually succeeded in obtaining additional specimens, some showing traces of the internal characters.

The only species with which I have been able to effect a comparison is the previously mentioned *Pentamerus hospes*, Barrande,* with which our form agrees in its outline, and coarse, few costæ, but differs in the possession of the exceedingly well-marked sinus. *P.? costatus* is possibly allied to *P. tasmaniensis*, mihi,† from the Table Cape Conglomerate, Tasmania, but the want of the external shell in the latter renders it difficult to arrive at a satisfactory conclusion. However, there is no trace in *P.? costatus* of the rugged, terrace-like, concentric laminæ visible in *P. tasmaniensis*, or the deflected front and sides and consequent cuboidal outline.

In external appearance *P.? costatus* is not unlike some *Spiriferæ*, a likeness which is heightened by the shape of the mesial sinus, but so far as the material in my possession at present enables me to judge, the general facies of the species

* Syst. Sil. Bohême, 1879, V, t. 24, f. viii.
† Proc. R. Soc. Tasmania for 1882 [1883], p. 159, t. 2, f. 1, 3-8.

is more that of *Pentamerus* than of *Spirifera*, more particularly when the internal structure is examined (Pl. XI, Fig. 10.) This figure, representing a natural ventral section from the umbo forwards at about one-third of the distance into the interior, shows the short median septum and the dental plates enclosing the V-shaped or middle chamber.

Loc. and Horizon.—Limestone Escarpment, Portion 51, Parish of West Gooddradigbee, Co. Buccleuch (*J. Mitchell* and *R. Etheridge, Jun.*); Pentamerus Limestone ("Siluro-Devonian").

PENTAMERUS PUMILUS, *De Koninck.*

Pentamerus pumilus, De Koninck, Foss. Pal. Nouv.-Galles du Sud, Pt. 2, 1876, p. 94, t. 3, f. 3, 3*a*.

Sp. Char.—Shell subglobular. Ventral valve very regularly convex; umbo small, although very strongly recurved, projecting beyond the hinge line. Dorsal valve nearly as deep as the ventral, although slightly sinuated in the middle line; front margin slightly sinuous. Valves ornamented with fifteen slightly-curved angular costæ, quite simple and without furcation, the middle costa of the ventral valve being rather larger than the others and quite straight; the costæ are separated by well marked deep valleys. (*De Koninck.*)

Obs.—I have not seen this species. There are no characters indicated in Prof. De Koninck's description which would satisfactorily demonstrate it to be a *Pentamerus*, but in the illustration, Fig. 3*a*, there is every indication of an open fissure into which the dorsal umbo seems to protrude.

Loc. and Horizon.—Neighbourhood of Yass (*The late Rev. W. B. Clarke*); black compact limestone of supposed Devonian age, probably one of the Upper Silurian limestones displayed in Prof. T. W. E. David's section.

GENUS CYRTINA, *Davidson*, 1858.

(Mon. Brit. Carb. Brachipoda, p. 66.)

Cyrtina carbonaria, *M'Coy.*

Cyrtina carbonaria, var. australasica, *Eth. fil.*

Cyrtina carbonaria, M'Coy, var. australasica, *Eth. fil.*, Proc. Linn. Soc. New South Wales, 1889, IV (2), Pt. 2, p. 210, t. 17, f. 6–8.

Obs.—In a small collection of Permo-Carboniferous fossils, made in N. W. Australia by Mr. W. W. Froggatt, for the late Sir W. Macleay, and now in the Macleay Museum, I detected a variety of the typical Carboniferous shell, *Cyrtina carbonaria*, M'Coy, and gave to it the varietal name of *australasica*. A description will be found at the above reference.

Cyrtina septosa, the commoner of the two British species, has already been determined from a New South Wales locality by the late Prof. De Koninck,* but *C. carbonaria* was unknown to me from this Colony until an opportunity was afforded, through Prof. T. W. E. David, of looking over a few fossils collected by Mr. F. B. Gipps from the neighbourhood of Cape Hawke, and associated with *Productus cora*, d'Orb., and a *Leptodomus*, the latter probably new.

Mr. Gipps' specimen has lost the whole of the shell, except at the back of the umbo, and on the shoulders of the ventral valve. It is now, with this exception, an internal cast, with the impressions of the coarse radiating costæ visible towards the front, and the ventral septum is also preserved. The sinus was shallow. So far as the specimen goes, it coincides with the form of the above variety, and may, I think, be accepted as indicating its occurrence in New South Wales.

Loc. and Horizon.—Neighbourhood of Cape Hawke, Co. Gloucester (*F. B. Gipps.*)

XIII.—Geological Notes on the Swamp Oak and Niangala Gold-fields: by G. A. STONIER, F.G.S., Geological Surveyor.

I.—General Physical Features.

SWAMP Oak is partly in the Parish of Loftus, and partly in that of Ainsley, Co. Parry, and is distant from Tamworth twenty-five miles, a few degrees south of east, while Niangala is nine miles further in a south-easterly direction, and situated in the Parish of Walcha. Both places are within the watershed of the Swamp Oak Creek, which rises in the Great Dividing Range, and, flowing in a north-westerly direction for fifteen miles, turns to the west and joins the Mulla; it is then known as the Cockburn, runs into the Peel River a couple of miles to the east of Tamworth, and flows into the Darling through the Western Plains.

Swamp Oak Creek is intermittent, although water can always be obtained by sinking, but the Mulla is permanent, and when the former is dry, the latter is a strong flowing stream.

The physical features of the two districts present marked differences.

Swamp Oak Township is two thousand four hundred feet above sea-level by Aneroid levels, and is situated on a gentle well-grassed slope, which was formerly used as a "Top Station" for the Swamp Oak Creek Station. The surrounding country is mountainous, and consists of well-timbered hills, having rocky and in places almost precipitous sides.

* Foss. Pal. Nouv.-Galles du Sud, Pt. 3, 1877, p. 115, t. 15, f. 2, 2*a*.

Niangala is situated on a table-land, and by barometer levels, three thousand five hundred feet above sea-level. The water-parting of the Great Dividing Range occurs a short distance easterly, and is sharply defined. The table-land continues easterly for some miles, but the western fall is soon broken, in places very abruptly. The table-land forms part of the New England Table-land, and presents only slight undulations as a result of erosion.

II.—Geology.

The formations developed may be classified as follows:—

(1.) Recent Alluvium.—Quaternary. } Cainozoic.
(2.) Basalt. } Tertiary. } Cainozoic.
(3.) Tertiary Alluvium. } Tertiary. } Cainozoic.
(4.) Diorite.
(5.) Granite.
(6.) Serpentine.
(7.) Mudstones, sandstones, &c., more or less altered.—Lower Carboniferous (?)

(1) *Quaternary.—Recent Alluvium.* As the various watercourses are chiefly confined and have precipitous sides, there has not been the opportunity for the accumulation of large areas of alluvium. The patches, which have been formed, are isolated, and consist chiefly of quartz-sand and pebbles, more or less rounded, of the altered mudstones. Gold has been obtained since 1852 in Swamp Oak Creek; and at the present time in the Cockburn River, particularly after rain, pieces weighing up to five pennyweights can be obtained. In Swamp Oak Creek, from its junction with the Mulla almost to its source, grains up to half-a-pennyweight are found. As a rule the gold is shotty and differs entirely from the fine gold that is obtained from the reefs, so that the older river courses may perhaps be found to contain coarse gold. Several of the alluvial patches are worth a trial, but, as the water is strong, the work will be attended with some difficulty.

(2) *Basalt.*—This formation occurs in oval patches near Niangala, and towards Walcha occupies a large tract of country, and furnishes the regularity of outline which is characteristic of the New England Table-land. It consists of a coarse olivine-dolerite, well crystallized and rich in olivine. The older alluvials, to which reference will next be made, underlie the basalt.

(3) *Tertiary Alluvium.*—About a mile and a half north-west from Niangala, an outcrop of drift has been discovered, and a couple of shafts sunk, which show the wash to be several feet in thickness and of a bouldery nature. The pebbles consist chiefly of quartz and altered slate with several quartz boulders up to two feet in diameter. Colours of gold are said to have been obtained, but the work

done has not been of a character to test the lead at any one spot; it is certainly worthy of further attention. Between Niangala and Walcha there is a large area occupied by basalt, which overlies in places old water-courses. These leads may be difficult to trace, and in places wide, but they are likely to carry payable deposits of gold where they have traversed auriferous strata, and should repay the time devoted to prospecting. It is difficult to fix the exact age of the lead discovered at Niangala, as Palæontological evidence is not available, but it is probably contemporaneous with the wide-spread leads at Nundle. In the latter the width of the channel which contains the auriferous drift has not been proved. The superficial alluvium is ten chains wide in places, so that it is not easy to locate the position of the deepest ground. An important point, too, is the occurrence of a bar which runs parallel to the course of the channel, and to the north of Nundle has increased the difficulty of determining the position of the wash-dirt. It is not to be inferred that the same width of alluvium will be found at Niangala, but the occurrence is mentioned to emphasise the necessity of the leads being properly tested before they are pronounced to be valueless.*

(4.) *Diorite.*—This rock occurs on both fields in a well-marked axis of upheaval, and is of the utmost importance, as it has probably occasioned the veins and furnished the precious metal.

At Swamp Oak the axis runs north-west, the dyke being well defined, and varying from eight feet up to a chain in width. From the cemetery, near the New Year Gift Mine, it can be traced in an almost unbroken line northerly, until it crosses the Swamp Oak Creek, then turns slightly to the west, and after a short break opposite the Rising Moon Battery, can readily be followed to the Mystery Lease, when turning almost at right angles for a short distance, is then lost. Overlapping this line, and a few chains westerly, another dyke starts at a gully to the south of the Victory Tunnel, and goes northerly to the Mystery Shaft, where it turns to the west, and, crossing the Highland Mary Lease, passes to the west of the Nelson Blocks, and across the northern corner of the Recreation Reserve. No attempt was made to trace it further either north or south, but it doubtless continues in both directions, and, in prospecting towards Nundle or Walcha Road, should be an invaluable guide. There do not appear to be any parallel or cross dykes. On the Carbine Block there is a patch, a chain and a half square, which is probably a boss indicating the existence of a much larger mass underneath, of the same age as the dyke. Doubtless other dykes occur, either outcropping, or at some little depth below the present surface, and it must be remembered, that, since the intrusion of the diorite, a considerable time has elapsed, and the country has been subjected to extensive denudation.

* For information on the Nundle Leads, see a "Report on the Hanging Rock and Nundle Gold-field" by the late Mr. C. S. Wilkinson. *Ann. Report Dept. Mines N.S. Wales for* 1888 [1886], p. 132.

At Niangala the dyke is not so wide as at Swamp Oak, nor does it make so bold an outcrop, but it can readily be traced from the Golden Spur Mine to the Jersey Lily Claim. Its width is difficult to determine, but does not exceed twenty feet. Immediately to the south of the Golden Spur it does not appear to outcrop, nor has any vein been discovered in the same direction.

The dykes are classified as later than the granite, because the country between the two auriferous zones has undergone alteration, and is traversed by quartz-veins which are not auriferous, while at Swamp Oak there is evidence that a vein resembling those referred to, has been reopened and become gold-bearing. These facts appear to find their explanation in the influence of the diorite belt, and not of the granite, and to justify the proposed classification, although the evidence is not clear enough to establish the later age of the diorite.

The direction of the Swamp Oak dyke bears N. 20° W. The upheaval does not appear to have been violent, as reversals or even flexures of strata are not distinguishable, and only such fissures as were inevitable have been developed.

The rock is holocrystalline, but varies in degree of crystallization, and at Niangala appears macroscopically to be a felspar-porphyry. But, under the microscope, it is seen that the only primary mineral present of any importance, whereby to determine the rock species, is felspar. Both orthoclase and triclinic felspar are developed; the latter predominates. It is clear from the fractured state of the crystals that the rock has been subjected to stress prior to its final consolidation. A ferro-magnesian mineral has been present, and is quite replaced by mica, with a little chlorite, epidote, and actinolite (?). Probably it has been amphibole, and there seems to have been an interaction between it and the felspars. Some magnetite is also present, but there is neither olivine nor quartz. It is clear that the rock belongs to the intermediate type, and as there are both monoclinic and triclinic felspars it should perhaps be classed as a syenitic-diorite. The specific gravity of a specimen from Swamp Oak, determined at the Sydney Mint, is 2·881, and of one from Niangala 2·924.

5. *Granite.*—Granite occurs in the form of a dyke, averaging about thirty-five feet wide, of felspar porphyry, and is found on the eastern extremity of the auriferous belt at Swamp Oak. It is well defined, and can easily be traced. It starts at G. L. 58, and crosses the Commotion Lease, runs to the east of the Carbine, and just within the western boundary of G. L. 67, and continues in a direction N. 30° W. about ten chains to the east of the north-eastern corner of the Rainbow Lease.

The rock is compact, with a slightly slaty-grey base, in which the felspar crystals are well defined, and of a yellowish white tint. Some of these felspars weather a reddish-brown and have much of the appearance of orthoclase, but many

are unaltered and are probably oligoclase, as they show fine lineation; hornblende and primary and secondary mica are also present. To the east of Niangala is found the western limit of the New England Table-land granite which outcrops also near Paradise.

The intrusion of the granite has crumpled the beds on the western side for a width of twenty-two yards.

6. *Serpentine.*—A large mass is found to the west of the Mulla in the Parish of Ogunbil with characteristically irregular and dirty brown outcrop, bold in places, and forming prominent rocky faces with scanty vegetation, and, at the flanks of the hills, yielding rich alluvial soil, caused by denudation of ultra-basic rocks. Its width is about a mile, and the eastern boundary bears north by west. The mass thins in a northerly direction, and it is doubtful if it can be correlated with either the Moonbi (Beedle's) or the Black Jack outcrop. From Barraba the serpentine can be traced for a long distance in a southerly direction, but, on approaching Tamworth, it thins, so that the Mulla area may be an inlier.

At Barraba it would appear that, the occurrence of gold is dependent upon the serpentine, which, so far as proved, has not had the same influence in the Nundle District. The question, however, cannot be looked upon as settled, and it is important that veins near the junction of the serpentine with the sediments should not be neglected.

That the serpentine at Barraba, is an intrusive rock* is evident both from the junction-line seen in the large sections, as well as in a hand specimen which was secured by Professor David during our trip through New England in March, 1891.

7. *Lower Carboniferous Mudstones, &c., more or less altered.*—The sediments occupy a very large area in both fields, and consist of mudstones, sandstones, &c., more or less altered, occuring, in the unaltered state, in small patches only. It is, however, the occurrence of these patches, as well as the similarity of the beds generally to much of the sedimentary area in New England, which has induced the proposed classification. That it is open to question is admitted; but after repeated observations the Author has come to the conclusion, that a large area in New England† may ultimately be referred to the Lepidodendron Series, which is considered to be Lower Carboniferous.‡ In going hurriedly over the section it is difficult to trace any break from the beds under consideration to those belonging, without doubt, to the Lepidodendron Series; at Barraba, also, the unaltered rocks can be followed into beds altered, as are some of the Niangala rocks, with independent cleavage, &c., there being no apparent break in the sequence.

* Mr. W. Anderson in a "Report on the Bingera and Barraba Gold-field" (*Ann. Report Dept. Mines N. S. Wales for* 1888 [1889], p. 182) says that this rock is in all probability an altered peridotite, which in the unaltered state was intruded amongst the slates.

† Ann. Report Dept. Mines N.S. Wales for 1891 [1892], p. 261.

‡ R. Etheridge, Jun., Records Geol. Survey N.S. Wales, 1891, II, Pt. 3, p. 119.

The metamorphism to which the rocks have been subjected is selective. Prior to the formation of the reefs, some of the beds have been opened for a certain distance along their strike, and this has allowed the percolation of silicified waters. Thus the alteration has been patchy. In some cases it appears to have been more intense close to the western side of the reefs, and there the rock ranges in a short distance from a claystone up to a quartzite. Speaking generally, the amount of silicification to which the rocks have been subjected has been great, and quartz-veins penetrated them in all directions, some following, and others cutting across the bedding planes at various angles.

At the junction of both the diorite and the serpentine with the sediments the immediate contact beds have been altered, but there appears to have been little opposition to the passage of these eruptive rocks. The granite, however, has caused not only silicification on a large scale, but for twenty yards on the western side of the granite dyke at Swamp Oak, the rocks have been contorted, the plications varying in width from a sixteenth of an inch upwards. The contortion has been accompanied by the infiltration of silicified water, which has passed into the opened bedding planes and deposited silica, which now appears, as if interbedded. The contortion of slate in the district was noted by the late Rev. W. B. Clarke in 1852. The occurrence is by no means uncommon in the northern district.

As a rule the dip is obscured by jointing and cleavage planes, and, it is only in odd places, that the lines of stratification can easily be distinguished. At Swamp Oak Township the general strike is N. 15° W., with a dip to the west at 37°, increasing in a westerly direction. On the Storm King line of reef the rock is a greenish grey argillite, in which the jointing is well marked, and might be mistaken for stratification planes, and is known to the miner as "greasy back." In the same series, but nearer Tamworth, there are sections which show clearly the obliteration of bedding planes in favour of jointing. At the Mystery Lease, the sediments have been more shattered than at any other portion of the field, and trenches several feet in depth, fail to touch the undecomposed and compact rock. Between Swamp Oak and Niangala, the rocks are more argillaceous, and as cleavage is developed they approach the slates in structure, but there does not appear to be a development of fissile slates. At Niangala the thin-bedded character of the mudstones can be seen in the Golden Spur Mine, but the section is not continuous over any large area, and cleavage again predominates.

The whole series is seamed with quartz, but it is only in the vicinity of the diorite dykes that the veins carry gold. At Swamp Oak, the auriferous belt is two and a quarter miles long, and one and a half miles wide. Immediately to the north and south of this area, there have not been any auriferous veins found, but as the tract of country is more or less of the same geological formation, there is

The veins are well defined, and do not appear to have been subjected to any complicated system of faulting; but there is evidence of a fault with a throw of about forty feet, which should not give much trouble. The deepest shaft is one hundred and ten feet, and the work already done shows that the rich parts will be found to run, chiefly, in shoots as at Swamp Oak.

A detailed reference to the mines will be found in the Annual Report of the Department of Mines and Agriculture of N.S. Wales, for 1892.

XIV.—Report on a Visit to the Narrangullen, or Cavan Cave, Taemas, Murrumbidgee River: by R. ETHERIDGE, Junr., Palæontologist and Librarian.

[Plate XII.]

I.—Introduction.

THE Narrangullen Cave, as it is locally called, or Cavan Cave, as termed on the Colony Map published in connection with the "Reports of the Royal Commission on the Conservation of Water," was examined in January of this Year, by Mr. John Mitchell and the Writer, under rather disadvantageous circumstances, chiefly arising from difficulties of approach to the cave and distance from our base of operations. Our examination was not, under these circumstances, of that minute nature we should have liked it to be. This is the more to be regretted from the fact that the chambers of the cave are traversed by an underground creek. The Narrangullen Cave would well repay another and more minute exploration.

II.—Locality.

The three entrances to the Narrangullen Cave are situated at the foot of a steep hill of limestone, about thirty yards on the western side of the boundary between the Parishes of Narrangullen and Taemas, Co. Cowley, on Portion 1, within the former parish, and, as near as we could locate it, opposite to Portion 49 of the latter parish. Below the hill, on the side whence the entrances lead inwards, is a small alluvial flat forming a *cul-de-sac*, led into from the south-west, by a moderately-open and not very long gully, called Cave Creek. The flat, having no outlet for its drainage waters, the latter disappear by percolation, and find their way into the cave; but in flood time the mode of escape of the water is only too apparent, by passing down the two lower entrances. Against and within the lowest of these are piled tons of dead timber, varying in size from mere sticks, up to large trunks and butts of trees, mixed with silt and general *débris*. To such an extent is this packed and wedged within the lowest entrance, that ingress is here impossible; but at the

second hole, a few yards higher up the face of the hill, an inward passage can be accomplished, after a little squeezing through the accumulated rubbish. We entered by this opening. The main entrance, however, is by the third aperture again a few yards higher up the hill, and this way is comparatively easy. The course of the drainage water of the Cave Creek flat, when once picked up within the cave, is traceable only for a comparatively short distance, when it disappears further underground, to reappear on the opposite side of the hill, and ultimately reach the Murrumbidgee River, its entire length, from entering on one side the hill to leaving it on the other, being, according to local current report, about half a mile. Portion 1, Parish of Narrangullen, is in the name of Alexander Raby Riley, but I was informed, is now the freehold of Dr. Campbell, of Yass.

III.—The Cave Chambers.

On entering by the middle of the three openings, a short drop of eight or ten feet is encountered, passing thence into a small chamber, narrowing at its further end, and then opening out into a large oval hall, partially illuminated by a stream of daylight, from the uppermost of the three entrances. On entering this chamber the sound of running water is heard, the creek having found its way through from the flat above. It flows along the bottom, or western side of the chamber, the remainder of the latter being taken up with a large talus proceeding from the daylight opening before referred to. At the further end of this hall, which, for the sake of distinction, may be called Chamber 2, the rivulet disappears under masses of fallen limestone, and stalagmite, and over this the explorer has to climb before reaching the inner portions of the cave. Chamber 2 is but little short of one hundred and twenty feet long, and too high for the faintest estimate approaching accuracy to be made. On crawling over the slippery surface of the the fallen blocks of limestone, at the inner end, under a low roof, the rivulet is again struck in Chamber 3, a huge, gloomy, black space, even larger than the preceding chamber, being at least two hundred and twenty-five feet in length. The creek winds its way along the bottom, disappearing at the further extremity, at the side of an immense irregular mound composed of limestone, stalagmite, and earth. On surmounting this obstacle, a passage is entered, more or less in red earth for some sixty feet, which has to be traversed on hands and knees. This leads to a crevice-like passage, opening into Chamber 4, a long irregularly-formed vacuity. On entering this chamber there is a rather fine, although not very large, stalagmo-stalactitic formation on the right-hand side, resembling an altar and canopy over it, the latter consisting of a series of organ-like flutings. A short distance beyond this a stalagmitic terrace crosses the chamber, marking off the larger half of the remaining portion as a shallow, miniature lake, about one chain in length. The roof of the chamber here descends and the walls come together, rendering the succeeding portion tunnel-like, the water again resuming its rivulet-like form where the chamber reopens, meandering between small sandy

and shingle banks, until lost on the lefthand side, apparently through a fissure in the floor, or just at the junction of the floor and roof, noiselessly, and without commotion. This is the last point where flowing water was observed by us.

At the end of this irregular chamber, attaining a length of at least three hundred and sixty feet, the floor is occupied by a series of very beautiful, miniature, brown stalagmitic terrace-pools, placed transversly across the chamber, each little pool somewhat semi-lunate in shape, and at a rather lower level than the one behind it. This line of terraced-pools is nearly one chain in length. The pools were filled with clear cold water. From the end of this terrace an upward passage leads to the fifth and last chamber. We say last, because we found no further ingress could be made, from fallen material, and general cave rubbish. A number of good stalactitic and stalalmitic formations are visible in this chamber.

In all, the Narrangullen Cave, so far as explored by us, is from the south entrance, about two hundred and sixty yards long.

IV.—General Remarks.

According to the statements of local residents the Narrangullen Cave enters both from the south and north sides of the hill it penetrates, the former being the intake, the latter the exit of the rivulet. It was the exit portion we were unable to visit, and have no idea, therefore, of the distance invisibly traversed by the water between the two portions. Assuming the entire course to be half-a-mile, as reported, we were surprised to find the traversable part of the cave comparatively so short.

The chambers are very dirty, arising no doubt, in the first instance from the amount of sediment brought in by the water; and secondly, from the existence of many hundreds of bats.

As rock excavations, the chambers are remarkably fine, very lofty, with irregular, and in some places jagged roofs, and rough rock-strewn floors.

The amount of cave-earth, as compared with that in the Goodravale Caves is inconsiderable, and we did not observe any traces of fossil bones.

PLATE X.

Pentamerus Knightii, *J. Sowerby.*

Fig. 1. Natural section of the ventral valve along the septum, showing the latter and one of the dental plates. Yarrangobilly Caves.

Fig. 2. Exterior of the same half, with coarse well separated costæ.

Fig. 3. The united halves, with the expanded front of the shell, and the long septum extending quite to the latter.

Fig. 4. Another specimen with the valves in apposition, the flanks more or less devoid of costæ, &c. Kerr's Creek.

Fig. 5. Side view of a young specimen showing flattened and indistinct costæ. Quedong.

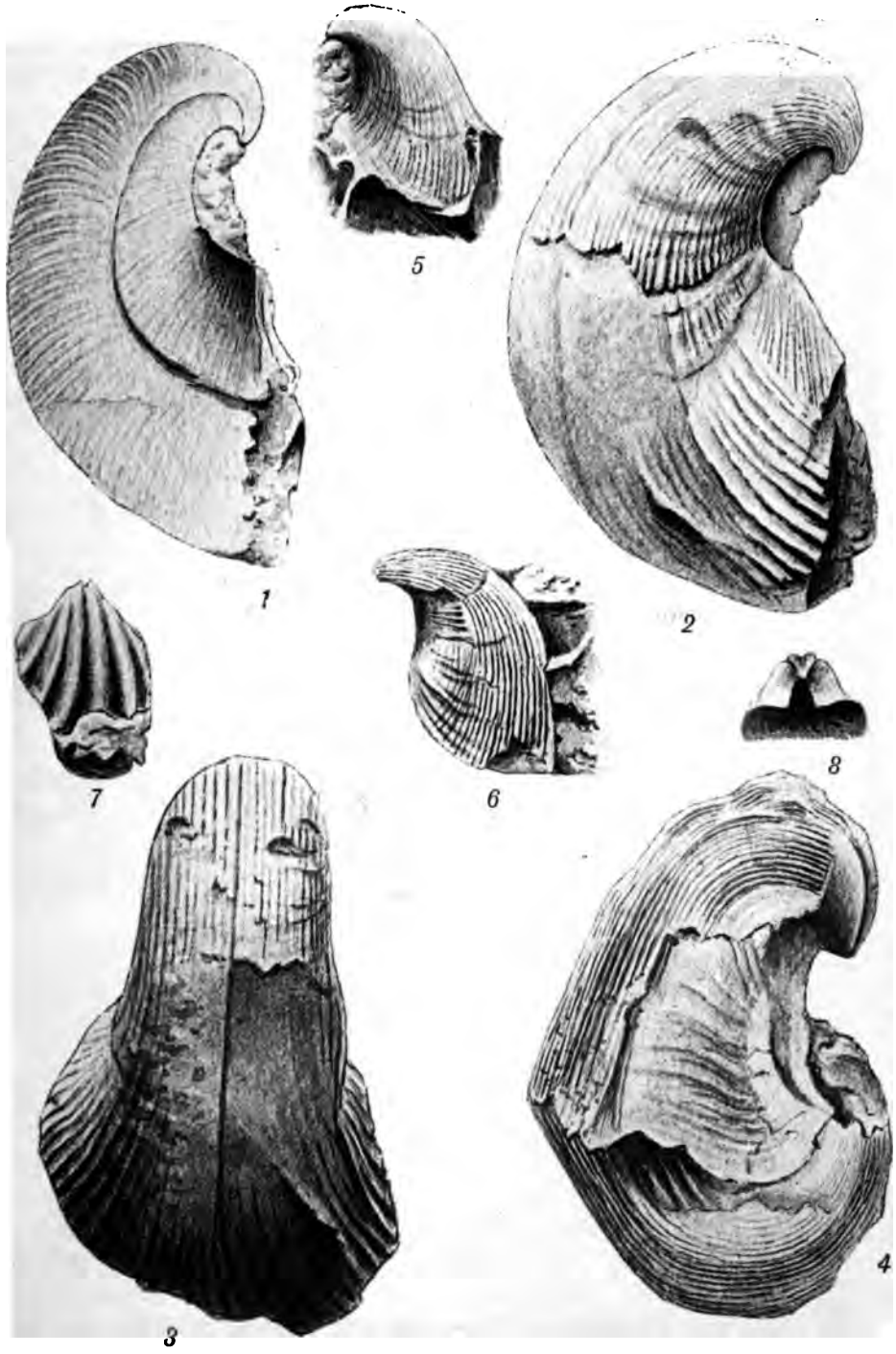
Fig. 6. Another young individual in which the umbo is excentrically curved, and the costæ better defined. Forest Reefs.

Pentamerus? costatus, *Eth. fil.*

Fig. 7. Exterior of the ventral valve with the few coarse costæ, and narrow sulcus. Goodravale.

Fig. 8. The same specimen—with its channeled umbo and open fissure.

Drawn from nature by Mr. G. H. Barrow, Australian Museum.



Reproduced by Heliotype.

PLATE XI.

Pentamerus Knightii, *J. Sowerby.*

Fig. 1. Front view of a specimen to show expansion of shell, and coarse costæ. Quedong.

Fig. 2. Natural section of the moiety of half a ventral valve, with the umbo highly incurved. Yarrangobilly.

Fig. 3. Front view of another ventral vale to show a slight] tendency towards a sulcus. Quedong.

Fig. 4. Natural weathered section of a ventral valve with the long septum, dental plates, and narrow V-shaped chamber. Walli.

Pentamerus linguifer, *var.* Wilkinsoni, *Eth. fil.*

Fig. 5. Dorsal view of valves in apposition illustrating the peculiar fold. The specimen is slightly distorted. Bowning District.

Fig. 6. Ventral view of the same to show the wide plain sulcus.

Fig. 7. Dorsal view of another specimen, showing the highly incurved and depressed umbo. Hatton's Corner.

Fig. 8. A young form. Bowning District.

Fig. 9. Internal cast of ventral valve, showing vascular system. Hatton's Corner

Pentamerus? costatus, *Eth. fil.*

Fig. 10. A weathered section of the ventral valve, with the septum and dental plates vertically cut. Goodravale.

Pentamerus hospes, *Barrande.*

Fig. 11. Decorticated ventral valve, with cast of the septum. Bowning District.

Fig. 12. Internal cast of a dorsal valve of a more triangular shape. x ½. Bowning District.

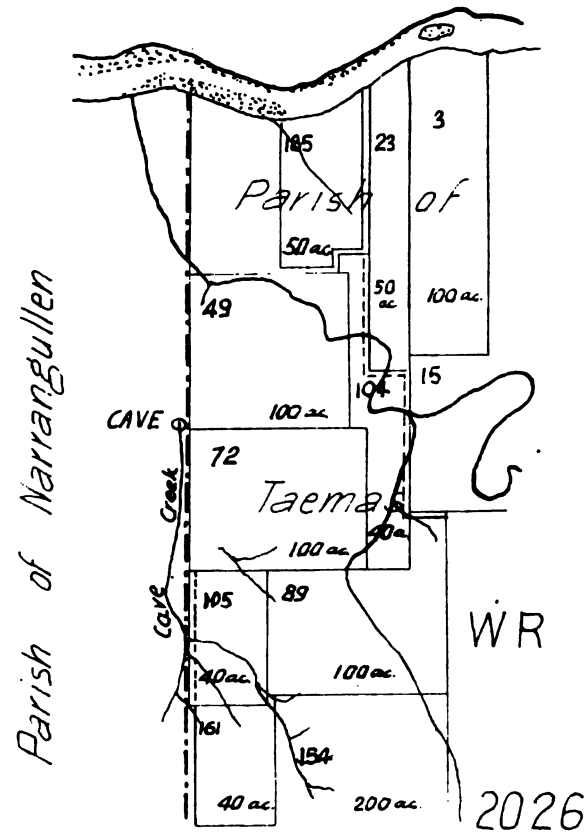
Drawn from nature by Mr. G. H. Barrow, Australian Museum.

Reproduced by Heliotype.

PLATE XII.

Plan of part of the Parishes of Taemas and Narrangullen, County of Cowley, showing the position of the Narrangullen Cave.

Scale 40 chains to 1 inch.



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XV.—On the Occurrence of Leucite-Basalt at Lake Cudgellico. (Cargelligo): by G. A. STONIER, F.G.S., Geological Surveyor.

LEUCITE rocks, so far as has been yet observed, occur as outliers of lava, occupying limited areas, although widely separated from each other. In New South Wales they have been found only in the form of Leucite-Basalts, and have been recognised in the following localities:—

(1) Byrock Mt., near Bourke.
(2) El Capitan, near Cobar.
(3) Harden, south of Young.
(4) Lake Cudgellico, west of Forbes.

El Capitan is forty miles south from Byrock, and Lake Cudgellico one hundred and sixty miles south from El Capitan. Harden is one hundred and forty miles south-east from Lake Cudgellico, twenty miles south from the township of Young and one hundred and fifty miles from the coast.

The first recorded occurrence of leucite in Australia followed Professor David's examination of the artesian water area around Bourke in 1885.*

In 1887, the El Capitan rock was discovered conjointly by Mr. Geological Surveyor W. Anderson and the Rev. J. Milne Curran; in 1891, the latter gentleman noted the Harden rock, and in August 1892, the Author of this paper found Leucite-Basalt at Lake Cudgellico.

* Min. Mag., 1887, pp. 193-194.

The two former have been admirably described by Professor T. W. E. David, B.A., F.G.S., &c., and Mr. W. Anderson,* and also, in addition to the Harden rock, by Rev. J. Milne Curran.†

Lake Cudgellico is situated on the western boundary of the Central Division of the Colony, and within five miles of the Lachlan River. The surrounding country is mostly covered with Pleistocene red soil, but in the immediate vicinity of the lake the Silurian slates outcrop, and an intrusive (?) quartz and felspar porphyry forms a range of hills a little to the south-west of the township. The basalt runs in a thin tongue down to the lake, but the main mass is about a mile to the west. It presents the usual features characteristic of the Tertiary lavas, giving a rough stony outcrop, weathering into spheroidal boulders and yielding a scanty soil and vegetation. The flow does not cap the higher hills of quartz and felspar porphyry, but rests on the lower hills of Silurian slates. Its under surface is scoriaceous, and in one place has a brecciated or tuffaceous appearance. Prospecting operations have hitherto failed to reveal the existence of any contemporaneously formed alluvial deposits under this sheet, and its age, although in all probability Tertiary, is, therefore, at present undeterminable.

In hand specimens the rock is of a bluish black colour, compact, and fine-grained, but rendered distinctly porphyritic by small crystals of olivine, which can readily be detected without the aid of a pocket lens. Seen in thin sections the rock is micro-crystalline, and composed chiefly of leucite, olivine, magnetite, and augite, with a little microlitic base consisting of augite, magnetite, and leucite.

The leucite is micro-crystalline, and occurs as grains, aggregations, and amorphous masses. The first mentioned are, as a rule, irregularly shaped, and do not show, except in the case of a few small crystals, the typical polyhedral sections. Leucite is very plentiful and its inclusions are very numerous, and arranged in more or less perfect zones characteristic of the mineral. Its form of occurrence as amorphous masses is peculiar, as the latter have followed the contour of a typical crystal, and show its characteristic crystalline form more clearly than the mineral itself does. The inclusions consist chiefly of colourless glass, microliths of augite, opaque granules of magnetite, and a few rods of apatite (?) The leucite is not evenly distributed, but is frequently arranged in a circular form enclosing portions of the base as described from the Byrock slides. It would appear generally to have been the last mineral to crystallize, but in places to have intercrystallized with the magnetite and augite, and in one portion of the slide with mica also.

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* Records Geol. Survey N. S. Wales, I, Pt. 3, pp. 153-172.
† Proc. Linn. Soc. N.S. Wales, 1887, II (2), pp. 974-975, and Proc. R. Soc. N. S. Wales, 1891, XXV, pp. 210-211.

The olivine occurs as macroscopic grains, and is particularly fresh and free from decomposition; in this respect, as well as in the size of the grains, resembling the El Capitan rather than the Byrock specimens. Well-formed crystals are rare, and, although some of the edges are still fairly sharp, most of them are in various stages of corrosion, one grain in particular having unquestionably been reduced to a half of its former size. Only one crystal shows the ordinary six-sided section, and nearly all are traversed by irregular cracks chiefly transverse to the principal axis; along these cracks and the periphery of the crystal, the olivine has been altered to serpentine, in some cases with an aggregation of magnetite which has probably segregated from the olivine during its passage into serpentine. The mineral is colourless and shows several cleavage planes. The inclusions consist chiefly of magnetite as isolated crystals and aggregations.

The augite is found as microliths forming a large proportion of the base, and also in micro-crystalline, and occasionally micro-porphyritic prisms, generally elongated in the direction of the principal axis. They are coloured a light yellowish green, and show a tendency to assume a flow structure around the olivines. This structure, however, to judge from the broken appearance of one prism much elongated, may have been modified by a subsequent movement in the rock. Several of the crystals are multiple twinned, and might be mistaken for felspars, which latter do not appear to be present in the slide.

Magnetite occurs as small, isolated, and well-formed crystals, irregularly scattered through the base, and as aggregations near the edges of the olivines, which, in several places, are almost encircled by them. As inclusions in an augite prism, they are arranged parallel to the periphery of the crystal. Occasionally there is a tendency to assume the dendritic form, but the bulk of the magnetite occurs as isolated crystals.

Mica is of the rich brown variety, and occurs in long strips, most of which appears to be primary, with a little secondary mica close to the segregations of magnetite around the olivines. The primary mica shows a strong basal cleavage and encloses leucite and magnetite.

A comparison of the above description with those of the Byrock and El Capitan slides, shows that this Lake Cudgellico Leucite-Basalt resembles, in general microscopic characters, the latter rather than the former, and that it is differentiated from both chiefly by the greater size of its olivines and augites. A detailed description of the Harden rock has not been published.

Professor T. W. E. David has kindly confirmed the occurrence of leucite in the slides.

Since the above was written, the Author has examined, at several points, a basalt sheet at Bygalore, twenty-four miles east-south-east from Lake Cudgellico. The lava is found to be a Leucite-Basalt, resembling the Cudgellico rock in macroscopic characters; apparently it occupies an area of twenty square miles.

There has also been an opportunity of seeing the Harden rock *in situ*. One section proves to be of special interest, as it is the first instance in the Colony, and now recorded apparently for the first time, where a Leucite-Basalt is associated with an intrusive rock; the intruded rock is a coarsely-crystallized ternary granite.

XVI.—On the Occurrence of a Plant, allied to *Schizoneura*, in the Hawkesbury Sandstone: by R. ETHERIDGE, Junr., Palæontologist and Librarian.

[Plate XIII.]

Schizoneura, so far as known to the Writer, has never been recognised as an Australian Mesozoic plant, nor does the late Dr. Ottokar Feistmantel refer to it other than in a most emphatic manner, thus: "In Australia it does not occur."* *Schizoneura* is an exceedingly characteristic European Triassic plant, and more particularly of the Gondwana System in India.

Dr. Feistmantel has clearly shown the distinction between *Schizoneura*, *Zeugophyllites*, and *Noeggerathiopsis* (*Noeggerathia*, auctorum.)

In *Schizoneura* the leaves, really portions of the spathe, are numerous, long, linear, and biattenuate, opposite on the stalk, and consist of leaflets, united along their margins into one leaf. By this connection the spathe is formed, but "in the process of development, this sheath splits along the sutural lines either into the leaflets again, in various degrees of completeness, or, as it appears, much more frequently into two portions, generally equal in size, and spread out, so that they appear opposite."† These characters, remarks Feistmantel, distinguish *Schizoneurea* from *Noeggerathiopsis*.

In *Zeugophyllites* the "veins are much more numerous, and they belong to the *leaf itself*, which is not composed of several leaflets."‡. Very little seems to be

* Pal. and Mesozoic Plants E. Australia—*Mem. Geol. Survey N. S. Wales, Pal. Series, No. 3*, 1890, p. 77.
† Pal. Indica (Gondwana Flora), 1880, III, Pt. 2, p. 59.
‡ Records Geol. Survey India, 1877, X, Pt. 4, p. 200.

really known about this genus, and Feistmantel even suggests from Brongniart's original remarks, that the latter's *Zeugophyllites*, is, after all, but a *Schizoneura*,* and it seems very probable, therefore, that we have to deal with the former simply in its Australian aspect. In Australia we are acquainted with only one published species, *Z. elongatus*, Morris, an oblong-elongate leaf, truncate at the base, and with very numerous equal parallel veins, but of which the mode of attachment is even to this day unknown. Morris says,† "These leaves were probably sessile, or even amplexicaul, as might be inferred from their slightly thickened base, and pinnately arranged, at short distances, along a common stem, after the manner of the foliation of *Schizoneura*, Schimper." Morris' figure represents a leaf narrowed at the base, widest in the middle, and attenuated at the apex; in other words, generally lanceolate, as distinguished from the spathulate leaves of *Schizoneura*. Of *Zeugophyllites*, as I have before said, we know not the growth, but Feistmantel, shortly before his death, in his "Uhlonosné útvary v Tasmáni,"‡ referred the leaves to *Podozamites*. This may possibly turn out to be the case; but, so far as existing evidence goes, is purely an assumption. His figures are simply a reproduction of those given in Johnston's "Systematic Account of the Geology of Tasmania,"§ and, like Morris' original, are separate and unattached.

Morris described *Zeugophyllites* only from the Mesozoic beds of the Jerusalem Basin, Tasmania; M'Coy determined‖ what he believed to be the plant from the shales of Mulubimba, the Aboriginal name for Newcastle, and, therefore, from the Permo-Carboniferous Coal-measures. From this determination of *Z. elongatus*, its occurrence as a Coal-measure plant has crept into various lists and catalogues. As the distinction of the plants of our true Coal-measures from those of the overlying Mesozoic beds is a point of the highest practical importance, I have specially investigated the subject of these two plants, with the following result. The characters of the Tasmanian Mesozoic *Zeugophyllites elongatus* have already been pointed out. The Mulumbimba plant, on the contrary, from the specimens now before me, is widest for the entire apical third, thereby producing an elongately club-shaped leaf, very different in shape to its opponent from the higher series. The outcome, therefore, is, that the Newcastle supposed *Zeugophyllites* cannot be retained in that genus, and may, for the want of a better name, be known for the present as *Noeggerathiopsis elongata*, Dana, instead of *Noeggerathia*, the genus to which Dana transferred it;¶ the Tasmanian Mesozoic species remaining as *Zeugophyllites elongatus* Morris, notwithstanding Feistmantel's proposition to refer it to *Podozamites*, for which there is no published evidence at present.

* Pal. Indica (Gondwana Flora), 1880, III, Pt. 2, p. 61.
† Strzelecki's Phys. Descrip. N. S. Wales, &c., 1845, p. 250.
‡ Spisův Poětinych jubilejni cenou král ceski společnosti náuk v Praze. Cislo III, 1890, p. 103.
§ Pl. 22, f. 1 (4to., Launceston, 1888).
‖ Ann. Mag. Nat. Hist., 1847, XX, p. 152.
¶ Wilkes' U. S. Explor. Exped., Geol. X, 1849, p. 715.

The incongruity of uniting the two plants appears to have struck the late Rev. J. E. T. Woods, for he remarks:* "*Nœggerathiopsis elongata.*—This is a doubtful species which Dana identified with Morris' *Zeugophyllites elongatus*, but says that it was found at Newcastle, which is clearly an error."

Lastly, Mr. R. M. Johnston† considers *Z. elongatus*, Morris, to be a *Poacordaites*, and, therefore, a Conifer, basing his opinion on the supposed general resemblance of its leaves to those of the latter genus, and its constant occurence in company with quantities of coniferous wood in the Tasmanian Upper (or Mesozoic) Coal-measures. Possibly this may be the true explanation.

Mr. J. Evans, Manager of the Bulli Colliery, has recently presented numerous plant remains from the shale roof of the No. 1 Seam at that mine. Amongst these is the subject of Pl. XIII. In the Departmental Annual Report for 1891,‡ I returned this fossil, from imperfect knowledge, as *Zeugophyllites elongatus*, but on a more complete study I now see that it in no way differs from *Schizoneura*, except in one point. It displays six leaves, placed in pairs along a thin faintly striated stem, at regular distances apart, but I cannot detect any jointing of the stem, and so producing a division into nodes and internodes. The basal pair of leaves is the largest, the leaf on the left being the larger, and nearly perfect. It is four inches long, and half an inch wide, lanceolate in shape, truncate at the base and amplexicaul. The other leaves become smaller as the stem is ascended. The veins are simple, separate, sub-parallel in their middle course, and converging at the base and apex of the leaf, more so at the latter than the former.

Now, it will be observed that the mode of articulation is that of *Schizoneura*, the leaves, although not as broad and spathulate as some of those figured§ by Feistmantel in the Indian plant, are practically similar to many others.‖ On the other hand the leaves of our plant possess only five veins each at the utmost, which is less than in typical leaves of *Schizoneura*, wherein they are often as many as eleven,¶ but in some cases only six,** and even five.†† Feistmantel says‡‡ the "least number is five, six, seven on each portion . . . and, consequently, the portions (pseudo-leaves) are narrow." What is of more importance, however, is that neither of the leaves in the Hawkesbury plant shows any trace of splitting into pseudo-leaves. With the exception of this character, and the non-articulation of the stem—a feature on which I am inclined to lay very much less stress, as it may be purely accidental—our plant is to all intents and purposes a *Schizoneura*. That the

* Proc. Linn. Soc. N. S. Wales, 1883, VIII, p. 154.
† Proc. R. Soc. Tas. for 1886 [1887], p. 179.
‡ Ann. Report Dept. Mines and Agric. N.S.Wales for 1891 [1892], p. 269.
§ Pal. Indica (Gondwana Flora), 1880, III, pt. 2, t. 1 A., f. 2, t. 3 A., f. 1, t. 6 A., f. 1 and 3.
‖ *Ibid.*, t. 1 A., f. 4, t. 3 A., f. 2 particularly, and t. 10 A.
¶ *Ibid.*, t. 7 A., f. 1, t. 5 A., f. 4.
** *Ibid.*, t. 8 A., f. 1, t. 10 A., f. 5.
†† *Ibid.*, t. 10 A., f. 4.
‡‡ *Ibid.* p 62.

latter is not a *Zeugophyllites* appears pretty certain from its venation, and if Feistmantel is correct in referring *Z. elongatus* to *Podozamites*, the dissimilarity only becomes the stronger, for in this genus the leaflets are always alternate, here they are opposite.

To sum up, therefore, it may be stated that—(*a*). We have a plant from the shale roof of the Bulli Seam with leaves possessing the outline of those of *Schizoneura*; (*b.*) These leaves have the same arrangement on the stem, and method of articulation, but do not subdivide into pseudo-leaflets as in *Schizoneura*; (*c*) The venation approximates to that of *Schizoneura*, and not *Zeugophyllites*; (*d*) We have no direct evidence of the occurrence of the last-named genus in Australia.

Under these circumstances I shall provisionally content myself by placing this on record as *Schizoneura? australis.*

XVII.—Notes on the Rosebrook Caves, near Cooma: by W. S. LEIGH, Inspector of Caves.

[Plate XIV.]

THE limestone at Rosebrook, situated about nine miles north-east of Cooma, in the Parish of Woolumla, County of Beresford, in which a number of caves or large pot-holes have recently been discovered, has an area of about four square miles.

The northern portion, which is included in Reserve No. 1034, is about two thousand six hundred feet above sea-level. From this point, running generally south-east, over a gradually falling and undulating plain, it can be noticed cropping up at intervals for a distance of four or five miles. A continuation of this line would strike the Umaralla River at ten miles, and eight miles beyond this the Kybean Limestone, explored by Mr. R. Etheridge, junr., Palæontologist, and the Writer,* which would appear to be an extension of that under notice, the texture and colour of each being alike. Also, like the Kybean Limestone, it can hardly be called fossiliferous, as only a few scattered coral specimens were met with.

On or about the reserve, where the out-crop is most marked, the surface of the limestone is traversed by numerous joints and lines of fracture, intersecting each other at different angles, which presents a face of knife-edged ridges rising almost vertical.

* Records Geol. Survey N. S. Wales, 1892, III, Pt. 1, p. 21.

Towards the southern or lower end of the belt the limestone is covered at intervals with thick patches of alluvium, and where exposed the rock appears more solid and compact than on the higher ground, fewer crevices being noticed. At the northern end these natural openings and shafts in the limestone are numerous. Within a radius of four hundred yards about twelve of the most promising looking holes were enlarged and explored, and, although most of them were found to connect with more spacious cavities below, in only one instance, if viewed from a spectacular stand-point, did the search prove successful.

A descent into the opening referred to, which is situated on Portion No. 125, south of and adjoining the reserve, was effected after the removal of two slabs of limestone, which, having become wedged together near the surface, effectually covered the funnel-like shaft below. The total depth of the shaft, to floor of the main cave, is eighty feet. At twenty feet below the surface it is about two feet six inches in diameter, which varies very little for a further distance of thirty feet, at which depth a landing is effected on a narrow ledge of rock spanning an immense cavity, the main chamber of the cave, the floor of which is reached after a further descent of thirty-two feet. This chamber is about forty feet long by twenty feet wide, and averages thirty feet in height. The floor immediately below the entrance shaft is strewn with limestone *débris*, the sombre appearance of which is in marked contrast with the surrounding white stalagmitic bed. From the roof and rugged projections on the walls depend long tapering stalactites and "shawls," relieved at intervals with patches of crystallised and ripple-marked rock. Branching from the northern end of this chamber, running generally north-west, is a narrow circuitous passage about fifty feet in length, the whole surface of which, floor, roof, and side walls, is coated with glistening white calcareous growths. On emerging from the passage, the terminal chamber of the cave in the form of a pretty grotto, about twenty feet long by eight feet wide, is entered, which, by reason of its delicate coral-like stalagmitic floor, might appropriately be termed the "Coral Grotto."

The cave on the whole, though not large, is strikingly pretty and interesting, and the discovery naturally led to the belief that some of the many similar crevices, noticed in close proximity, would, on examination, be found to lead to cavities equally interesting and important. In almost every instance, however, after the entrance had been enlarged for a certain distance, only vertical shafts or "pipes" ranging in depths from twelve to one hundred and fifteen feet, were found. One of these shafts was opened out to a depth of seventy feet and bottomed on solid rock, the size of the natural opening varying very little the whole distance.

This, of course, proved an unsuccessful undertaking, but the next crevice tried, gave better results. At ten feet below the surface the natural shaft was found to break abruptly into a spacious cavity, the width increasing as one descends, until

at sixty-five feet deep, becoming circular, it is about twenty feet in diameter. At this point a narrow ridge of rock, running across the centre of the shaft, divides the cave into two branches, each of which being on a steep gradient, forms an obtuse angle with the main trunk shaft, and can be descended a further distance of fifty feet. With the exception of one or two small fissures, evidently old watercourses, no passages lead off from the bottoms of the shafts. A few isolated stalactites and "coral" patches, of a brownish tint, comprise the drip-stone specimens of the cave.

The other openings explored are simply vertical shafts of various depths ranging from two to three feet in diameter, and contain nothing of interest. In fact, the cave first noticed, so far as recent explorations have revealed, is the only one of the series, in the inspection of which one would feel somewhat recompensed for the amount of exertion required, and trouble experienced in descending and traversing it.

As before inferred, the northern portion of the Rosebrook Limestone appears to be thickly perforated with cavernous orifices or "pot-holes," and the fact of the lower floors of those inspected being covered with a plastic sediment of drift and waterworn boulders, exhibits abundant evidence of the passage of bodies of water through them, which settles temporarily on the lower levels, eventually escaping by percolation through small orifices and joints, into the lower limestone.

Some of the rock crevices were found to be filled, and the natural shafts partly choked with a deposit of red earth, which, on examination, proved somewhat ossiferous, a collection of bones being obtained from the deposit. They include portion of the remains of a Wombat (*Phascolomys*), a Wallaby, and a Native-cat (*Dasyurus*), in all probability of existing species. As no specimens of an extinct animal, such as found in the Wellington Caves, were obtained, the same remarks, as applied by Mr. Etheridge, referring to the bone deposits, in his notes on the Kybean Caves,* would apply in this instance. "It may be concluded that the accumulations in the Kybean Caves belong to the latter period of cave deposits, and not to the more ancient, such as those of the Wellington Caves."

It might be mentioned that in close proximity to the Caves was found in a horizontal crevice, formed by an overhanging rock, the more or less complete parts of a human skeleton, probably that of an Aboriginal. The remains, which were covered by a thin layer of soil, were too much decayed and friable for preservation, the skull even being in a number of pieces. Considering the small size of the cavity and the position in which the skeleton lay, it is evident that the body at burial had been tightly wedged between the lower limestone bed and the upper sheltering rock, thus following the universal practice of the aboriginals of disposing of their dead in the smallest possible space.

* Records Geol. Survey N. S. Wales, 1892, III, Pt. 1, p. 24.

XVIII.—Idiographic Carvings of the Aborigines at Point Piper, Rose Bay, Port Jackson, and at Hawkesbury: by R. ETHERIDGE, Junr., Palæontologist and Librarian.

[Plate XV.]

I.—Point Piper.

POINT Piper, forming the western promontory of Rose Bay, Port Jackson, is a low headland of Hawkesbury Sandstone, not more than thirty feet above high-water mark. The sandstone is broken up into several large rounded tables, separated by large joint-fissures, and on these the carvings are delineated. Point Piper forms part of the estate of Lady Martin, who was kind enough to allow Mr. G. H. Barrow and the Writer to make the requisite examination of the locality.

The first object to attract attention is the large fish (Pl. XV, Fig. 1.), twenty-two feet long, by twelve and a half wide, and within its outline are other subordinate carvings. This fish is remarkable for the roundness of its anterior outline, great bulk, and small well separated tail-flipper. It is different in type to any yet visited and recorded by us, and is second only in size to two of the immense fish visible at Flat Rocks, near Manly. It is divided at about one-third from the tail by an incised line.

Within the outline of the fish are four subordinate smaller fish (Pl. XV, Figs. 2-5.), each after a type of its own, and no two alike. Those at the anterior end of the larger fish appear to be grouped round a circle (Pl. XV, Fig 6.), whatever this latter may be intended for; but supposing the contiguous outline to represent the dorsal rather than the ventral line, it would not be too much out of position to represent the eye. At the posterior end is a shield (Pl. XV, Fig. 7.), with its longer axis parallel to that of the fish, with the usual transverse bars, and diamond shaped apices. It is four and a half feet long.

On another section of the sandstone table is a grand Kangaroo (Pl. XV, Fig. 8.), a trifle over ten feet high, etched in a north and south direction, and facing the east. The fore legs are delineated, with the hands distinctly carved, and one of the hind legs represented. The tail is also in full proportion, and the eye not forgotten. This is one of the best examples of a Kangaroo we have yet met with, in some respects even better than those above Bantry Bay, Middle Harbour. Contiguous, but further south, is the head alone of another

Kangaroo, excellently outlined (Pl. XV, Fig. 9.), and a nondescript fish (Pl. XV, Fig. 10.), seven feet long, without any particular character except its homocercal tail.

A third section of the rocky surface carries the rude figure of a man, with a squarish head (Pl. XV, Fig. 11.), and what is of rare occurrence, eyes depicted. The figure is five feet high, and has the knees and elbows typically angulated after the usual aboriginal manner.

II.—Hawkesbury.

This group of Idiographic Carvings is situated in a depression between two hills, on the Old Peat's Ferry Road, about three miles from Hawkesbury (Peat's Ferry), and five from Berowra Station. The road for some distance follows the crest of the divide between Cowan and Berowra Creeks. It passes directly over the large Hawkesbury Sandstone table on which the figures are delineated, but I regret to say, also, in a great measure obliterated. In pre-settlement days this must have been a most secluded locality, and well adapted to the sacred rites carried out at such spots. Several important and interesting facts are to be gleaned from this group of carvings, although it was found impossible to do more than copy the better preserved ones.

The following are the principal figures:—A fish (Pl. XV, Fig. 12.), twelve feet seven inches long, with one eye and the mouth shown, the latter open. The tail is square-ended, and there is a dorsal fin, curved in the opposite direction to that seen in nature. Immediately succeeding the fish is the usual male figure, the head towards the fish, and the arms extended above the head. The left leg is provided with a foot, the right without, or it has been obliterated by age (Pl. XV, Fig. 13.) Extending at right angles to the fish, and in a line with the male outline, and leg on to it, are a series of diminutive male figures, probably those of boys, and of which two are shown (Pl. XV, Fig. 14.) The line of boys extends for forty-five feet, and at its termination is the outline of a Kangaroo (Pl. XV, Fig. 15.), with the curvature of its back rather imperfect, co-mingled with a number of other indistinct figures. To the right of this is the figure of another Kangaroo with a badly executed head, and a very short fore limb (Pl. XV, Fig. 16.) Contiguous to the larger Kangaroo, at the end of the procession of boys is another man delineated (Pl. XV, Fig. 17), with the head sunk on the shoulders as it were, provided with a belt, and peculiar in having the penis represented by a single incised line, instead of the manner usual in these representations. The last object decipherable, for there are numbers of which nothing can be made from their weathered condition, seems to be meant for a canoe (Pl. XV, Fig. 18), with four divisions or stretchers.

III.—The Meaning of the Carvings.

So far as my memory serves me at present, no explanation of these Idiographic Carvings has been offered, at any rate, no detailed explanation, beyond that afforded by Dr. A. Carroll,* and a few remarks by myself.† Dr. Carroll regards them apparently both as totemic and symbolical. He says, "The various birds and fishes were the totemic or tribal emblems of other tribes";‡ and again—"the carvings and engravings of the original inhabitants of Australia are symbolical of their tribal myths and laws."§

The frequent occurrence of these carvings throughout the mid-eastern district forbids one ascribing the nature of Initiation, or Bora grounds, to all of them, a point on which I am quite in accord with Dr. Carroll;‖ no doubt the larger and more inaccessible ones were so, but to imagine solitary figures, or groups of two or three to be of this nature, is to recognise the almost indiscriminate consummation of those rites held most sacred by the Aborigines.

These minor groups Dr. Carroll looks upon as the records of "raids of tribe upon tribe, the conquest of districts by invading tribes . . . . the boundaries of hunting-grounds and tribal territories." On these points I am not at present in a position to express an opinion.

It is now known that the Aborigines, especially of the south-eastern portion of the Continent, depicted their Bora grounds, or Baiamai's ground, the ground of the "Great Creator"—that is to say those spots where initiatory religious ceremonies connected with the transfer of a male from the condition of adolesence to that of full manhood took place—with figures carved in the turf or soil, or on the butts of trees. Such grounds according to Dr. John Fraser were permanent. A spot of this nature is described near Wellington by Mr. J. Henderson,¶ who remarks—"A long straight avenue of trees, extended for about a mile, and these were carved on each side, with various devices, most of which were apparently intended to represent serpents, in all their different attitudes. On one extremity of this, the earth had been heaped up, so as to resemble the gigantic figure of a human being extended on his breast . . . . a narrow pathway turned off towards the left, and soon terminated in a circle, which was enclosed by a wall, composed merely of loose earth."

Another is described by Dr. Fraser,** who informs us that the presiding elders formed and cleared two circular enclosures, a larger and "a smaller," about a quarter of a mile from each other with a straight track connecting them; the trees that

* Centennial Mag., 1888, I, Nos. 1 & 2, p.p. 53 & 89.
† Records Geol. Survey N.S. Wales, 1890, II, Pt. i., p. 34.
‡ *Loc. cit.*, No. 1, p. 54.
§ *Loc. cit.*, No. 2, p. 89.
‖ *Loc. cit.*, No. 2, p. 90.
¶ Obs. Colonies N. S. Wales & V. D. Land, 1832, p, 145.
** Journ. R. Soc. N. S. Wales for 1882, XVI, p. 205.

grow around the smaller circle they carve at about the height of a man, often much higher, with curious emblematical devices and figures." The young initiate or *Boombat** was made to lie down in the centre of the larger circle, and, after other preparatory ceremonies, was led down between the avenues of carved trees to the smaller enclosure. Fraser adds that the Yùin tribe, a section of the Murring people, who extended from the Shoalhaven River to Cape Howe, placed along the path figures, moulded in earth, of various animals, and one of *Daramūlŭn*, "a spirit god," whom they feared.† The *Boombat*, who had been placed in the smaller circle was led to each of these objects, carved trees, or images, and allowed to look at them, when their significance was explained to him. *Daramūlŭn* was supposed to preside at the Bora as "Lord of the Mysteries," although in some tribes he was the second deity only, "not the supreme master, but the son of *Baiamai*, who ruled everything." Touching *Daramūlŭn*, Dr. Fraser says‡ that in the work of creation *Baiamai* was assisted by a *demiourgos* named *Daramūlŭn*, "and certain birds and animals are also associated with him as agents." On the other hand, quoting Howitt,§ he was the supreme spirit believed in from the "sea coast across to . . . about Yass and Gundagai, and from Omeo to at least as far as the Shoalhaven River, in a line approximately east and west."

Ceremonies of initiation, differing but little in detail, were practised by five large tribes in the south-east, notwithstanding a diversity of class systems, viz.:—The Wolgal, Ngarego, Theodora, Coast Murring, and Wirdijuri, forming more or less one nation or community, and occupying a very large area of New South Wales "from Twofold Bay to Sydney, and (including the Lachlan River) as far west at least as Hay."‖ In this community the ceremony is called *Būnan* or *Kūringal*, and again includes two circles, as at Wellington,—the great *Būnan* with a clear path leading to the small *Būnan* enclosed by boughs, with some of the trees around bearing figures or marks.¶ The initiates in this instance are shown the figure of *Daramūlŭn*, and instructed concerning him. At the conclusion of the various impressive ceremonies the procession of neophytes and old men on its way to the camp is halted, and the latter "having carefully cleared a piece of ground, proceed to mould in earth, in high relief, the life-sized figure of a naked man in the attitude of the dance . . . This is *Daramūlŭn*. The novices are brought and placed in front of this figure and the dance then takes place."**

The various objects exhibited are those instituted for the good of man by *Daramūlŭn*. Such a belief seems to have existed amongst the Kurnai of Gippsland, and probably other tribes likewise, for Howitt, speaking of the Kurnai, says,

* The name of the initiate varies in different tribes.
† Journ. R. Soc. N. S. Wales for 1882, XVI, p. 206.
‡ Journ. R. Soc. N. S. Wales for 1891, XXV, p. 262.
§ Journ. Anthrop. Inst. Gt. Brit. & Ireland, 1884, XIII, p. 193.
‖ Journ. Anthrop. Inst. Gt. Brit. & Ireland, 1884, XIII, p. 433.
¶ Journ. Anthrop. Inst. Gt. Brit. & Ireland, 1884, XIII, p. 440.
** Journ. Anthrop. Inst. Gt. Brit. & Ireland, 1884, XIII, p. 448.

"Long ago there was a great Being called *Mūngan-ngaur* [*Baiamai*], who lived on the earth, and who taught the Kurnai of that time to make implements, nets, canoes, weapons—in fact all the arts they know."*

Now, in endeavouring to apply the explanation afforded by these facts to the major groups of carvings, we are met at the outset by the absence of any remains of circles, or of pathways or objects connecting groups together. If such ever existed they have long disappeared. On the other hand, the objects portrayed bear such a close resemblance to those described by Messrs. Howitt and Fraser, respectively, and believed by the Blacks to have been instituted by *Daramūlŭn* for their good, that the conviction is forced on us that these large tabular masses of Hawkesbury Sandstone must have been selected as the sites of the *Bora* ceremonies of the local tribes. In the first place the figure of a man, or those of men, invariably present themselves at all the larger groups, and the absence of these figures at the smaller collections of figures is very marked. It is not invariably so, as Mr. J. F. Mann has figured† the outline of a man inside that of a fish at Berry's Head, one of the minor groups I visited some months ago in company with Mr. E. F. Pittman. These men outlines are portrayed with the arms and legs extended, always one or the other, usually both, and seem intended to represent a prone individual. We have seen that during the *Kuringal* of the associated Murring tribes the initiates were shown the figure of *Daramūlŭn*, and at the conclusion the old men moulded the figure of the god. The Page and Isis River Blacks, at the head of the Hunter River, made a rude figure of a man, from four to seven feet high, twenty-two feet long, and twelve feet wide, by laying down sticks and covering them with earth.‡ This figure was in the extended prone position. I think, therefore, that the idiographic male figure is intended to represent *Daramūlŭn*, or, when there are two this spirit and his paternal associate *Baiamai*.

The row of smaller male outlines (Pl. XV, Fig. 14.), are probably symbolical of the *Boombats*, who, as described by Fraser and Howitt, are made to lie down during certain portions of the south-eastern initiation ceremony. Such was also the case in the Wailwun Tribe, Barwon River;§ and amongst the Page and Isis River Blacks,‖ and other tribes. This line formation seems to have been a favourite one during these mysteries, for in one of the few pictorial representations of the *Bora* extant, contained in Lieut.-Col. Collins' work, "An Account of the English Colony in New South Wales,"¶ the initiates are represented seated in a line watching the elders performing the *Yoo-long Erah-ba-diang*.

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* Journ. Anthrop. Inst. Gt. Brit. & Ireland, 1885, XIV, p. 313.
† Proc. Geogr. Soc. Australasia (N. S. Wales and Vict. Branches), 1885, I, 5th plate.
‡ Macdonald, Journ. Anthrop. Inst. Gt. Brit. & Ireland, 1878, VII, p. 255.
§ Honery, *Ibid.* p. 254.
‖ Macdonald, *Loc. cit.*
¶ 2 Vols., 4to, London, 1798-1802 (Pl. 8).

We have seen how often shields are depicted in these groups. According to Dr. Carroll* the crossed shield was the emblem of a god, and also of fire; but in the Yūin Tribe, after the extraction of the tooth, an ancient, and probably sacred shield, handed down from past ages in the tribe, was sent round† accompanying the extracted tooth, to the various other tribes, with whom the operating tribe were in close connection.

Of the numberless other objects depicted amongst these carvings, some explanation may be given on a future occasion; in the mean time those interested will find the interpretation placed on them by Dr. A. Carroll in his paper‡ previously referred to. How intimately these figures are connected with that of the man, the following passage by Mr. Howitt will show, when speaking§ of the "exhibition to the novice of the representation of Daramulun, moulded life size in the ground, with examples dispersed round his figure, of all the weapons and implements invented by him for man's use."

In the Kurnai ceremony called the *Jeraeil*, after the initiates, or *Tutnurring*, are awakened from their last boyish sleep, and pronounced men, they are invested with the belt, and other articles of dress appertaining to manhood.‖ It is more than probable that it was to impress this on the mind of the initiate, that the figure represented in Pl. 15, Fig. 17., was provided with the belt.

Amongst the carvings figured from the Bantry Bay group, is that of a large tomahawk.¶ This is probably intended as the figure of *Daramūlūn's* tomahawk, "which he threw after the Emu, as he was descending by the path from the sky to the earth".**

According to a Kurnai legend, many of their ancestors, who survived a great flood, sent as a punishment, were turned into animals, birds, reptiles, and fishes, whilst *Tundun* and his wife became porpoises. The Coast Murring also had a legend how an eminent man of former times became a porpoise.†† Possibly some such belief may have extended as far north as our carving grounds, and a knowledge of it kept green by means of these sculptures.

* Centennial Mag., 1888, I, No. 1, p. 55.
† Fraser, Journ. R. Soc. N. S. Wales for 1882, XVI., p. 209.
‡ Centennial Mag., 1888, I., No. 1, p. 55.
§ Proc. Austr. Assoc. Adv. Sci. for 1891 [1892], III, p. 349.
‖ Journ. Anthrop. Inst. Gt. Brit. & Ireland, 1885, XIV., p. 311.
¶ Records Geol. Survey N. S. Wales, 1890, II, Pt. 1, t 2, f. 20.
** Journ. Anthrop. Inst. Gt. Brit. and Ireland, 1884, XIII, p. 452.
†† Journ. Anthrop. Inst. Gt. Brit. & Ireland, 1885, XIV, p. 314.

XIX.—The Australian Geological Record for the Year 1891; by R. ETHERIDGE, Junr., Palæontologist and Librarian, and W. S. DUN, Assistant Palæontologist and Librarian.

I.—Introduction.

IT is the intention of the Compilers, supported by Official recognition, to prepare annually for the "Records of the Geological Survey of New South Wales," a GEOLOGICAL RECORD of all Works, Reports, Papers, and Maps, coming under their notice bearing on the Geology, Mineralogy, Petrology, Palæontology, Applied Biology, Mining, and Metallurgy of the Australian Continent, Tasmania, and New Guinea, that have been published during the preceding year, with the view of affording assistance to the Reader in overcoming the Australian portion of the terrible mass of literature now flooding Geological Science, using this term in its broadest significance. With this view they cordially ask the co-operation of their fellow-workers in the other Australian Colonies and Foreign Countries, by sending their writings to the Library of the Geological Survey of New South Wales, at the Department of Mines and Agriculture, in Sydney.

The idea was conceived too late to publish the Record for 1891 in 1892, but a strong effort will be made in future to issue that for each respective year, as early in the succeeding twelve months as the publication of the various "Annual Reports" of the Colonial Mining Departments will allow, these containing by far the largest amount of local geological information. In doing this we depart, to some extent, from our recognized plan, in so far that the contents of the Annual Reports are noticed in the actual year of publication, instead of deferring it for twelve months, as it otherwise would be were the conception strictly adhered to. Thus, the Annual Report for 1891 is *published* in 1892, and in the ordinary way would be *recorded* in the Record for 1892, published in 1893; but in the case of this particular and like publications, and for the reasons stated, we prefer to anticipate matters.

The Record is published simply as a *Title-catalogue*, the duties of the Compilers in no way allowing more than this to be accomplished. The arrangement is under Author's names, or, when these are wanting, the leading word of the title; this is followed by the actual title, and then the abbreviated reference. Manuals in the general sense of the term, unless strictly Australian, will not be noticed.

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2. Etheridge (R., Jun.) On the Occurrence of an *Orthis* allied to *O. Actoniæ*, J. de C. Sby., and *O. flabellulum*, J. de C. Sby., in the Lower Silurian Rocks of Central Australia, p. 13, pl. 2.

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III.—Geognosy, pp. 6–12.
IV.—Geology, pp. 12–17.
V.—Mineral Resources, pp. 17–35.
VI. Appendices, pp. 35–53, containing :—
A. Report on the Collie River Coal, pp. 38–41.
B. Report on the Green Bushes Tin-field, pp. 41–47.
C. Report on the Darling Range, p.p. 47–48.
D. Report on the Country passed over between Albany and Perth, including the Stirling Range, Jerramungup, the Gordon and Pallinup Rivers, pp. 48–53.

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II. Wardens' Reports for the Year 1891, pp. 26–80.

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V. Shakespeare, J. Annual Report of Northern Inspector of Mines for the Year 1891, pp. 108–117.

VI. Bennett, I. Annual Report of the Inspector of Mines of Central Districts, pp. 118–123.

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VI. MONTGOMERY, A. Notes on the Molesworth Calcining Process, pp. 12–13.

VII. MONTGOMERY, A. Report on the Macarthur-Forrest Cyanide Process for the Lixiviation of Gold and Silver Ores, pp. 13–14.

VIII. BELSTEAD, F.; SIMPSON, T.; MONTGOMERY, A.; HAWKES, S.; O'REILLY, C. Report of the Water-race Board to 30th June, 1891, pp. 14–15.

IX. MONTGOMERY, A. Report on the Proposal to Bore for Coal in the Township of Triabunna, Spring Bay, and its Neighbourhood, pp. 15–18.

X. MONTGOMERY, A. Addendum to Report on Coal found in the Neighbourhood of Spring Bay, pp. 18–19, with section.

XI. DIAMOND DRILL. Report of Strata passed through in boring for Coal in the Neighbourhood of Spring Bay, pp. 19–22.

XII. MONTGOMERY, A. Report on the Hydraulic Limestones of Maria Island, pp. 22–25, with map and section.

XIII. MONTGOMERY, A. Report on the Progress of the Mount Zeehan and Mount Dundas Silver-Lead Fields, pp. 26–43, with maps.

XIV. MONTGOMERY, A. Report on the Geological Structure of the Beaconsfield Goldfield, pp. 43–55, with maps, sections, and appendices.

XV. MONTGOMERY, A. Report on the General Geological Structure and Tin-bearing Gravels of the Gladstone District, pp. 57–72, with sections.

XVI. MONTGOMERY, A. Hydraulic Elevators, pp. 72–75, with plans.

XVII. DIAMOND DRILLS. Statement of work done, pp. 76–79.

XVIII. STATEMENTS. Pp. 79–82. [Gold won during years 1880–91; Quantity of Gold obtained during years 1880–91; Tin exported from Tasmania during years 1880–91; Coal raised during years 1880–91; Number of Miners, 1880–91; Number and Area of Leases held under "The Mineral Lands Act" and "The Gold-fields Regulation Act"; Number and Area of Leases in force, &c., 1890–91; Net Revenue from Mines; Dividends paid by Gold-mining Companies; Dividend Tax paid by Tin-mining Companies; Dividend Tax paid by Silver-Lead Mining Companies.]

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IV. MCCOY, F. Report on Palæontology of the Geological Survey for the Year 1891, p. 30.

V. TRAVIS, J. Officer in Charge of Statistical and Prospecting Branch. Report on the Expenditure of the Prospecting Vote, pp. 31–32.

VI. DUNN, E. J. Report on the Work done by the Underground Survey Party at Bendigo, during 1891, pp. 32–33.

VII. MINING INSPECTORS' GENERAL REPORTS, pp. 33–37.

VIII. MEEKISON, E. R., Inspector of Mining Machinery. Report on Mining Machinery, pp. 37–70, plans and sections. [Mining Boilers; "Garnier" Ore Concentrator; Mudie's Gold-saving Machine; Shedlock's Treatment of Refractory Ores; Lay's Vibrating Quicksilver Cradle; Tullock Concentrator; Arnold's Amalgamator; New Gold-saving Apparatus; Miller's Ore Washer; Carr's Disintegrator; Gates' Ore Breaker; Marsden's Crusher: "Steel Grinding Mill"; Dredge for Gold-bearing Rivers; Delbridge's Air-compressor; Joy's Valve Gear; Arthur's Patent Improved Method of Bushing the Cylinder of an Engine; Arthur's Patent Improved Counterbalance; Machinery at Berry Consols Extended Co.; Compressing Brown Coal into Briquettes; Gillott & Copley's Rotary Coal-cutting Machine; Brain's Electric Coal-cutter; Boyle's Gravity Hoisting Apparatus; Sleeman's Winding Indicator; Electric Hoist; Appliances used in Boring at North Magdala Company's Shaft, Stawell; Seale's Patent Water-purifier; Sleeman's Water-heater; Settle's Patent Water-cartridge; Francis' Patent Tamping Plug; Ventilating Fans; Indestructible Faucet; Strobach's Wire-rope Holder; Ratchet Screw-driver; Ramsay's Patent Levelling Staff; Underground Dams; Wells and Shafts; Miners' Thrift and Employers' Liabilities; Accidents in Mines; Tests of Victorian Timbers.]

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IX. FULTON, R.; NAYLOR, J.; COATS, J.; BARNES, B. Report of the Board of Examiners for Engine-drivers, p. 71.

X. PATENTS (MINING). Lists of Patents (Mining) granted in Victoria during the Year 1891, pp. 71–72.

XI. BORING. Synopsis of Boring Operations in search of Auriferous Leads and Reefs, and of Coal Seams, pp. 73–100, maps and sections.

XII. STATISTICS. Statements Nos. 1–61, pp. 101–137. [Yield of Gold from Alluviums and Quartz Reefs in 1891; Total Yield of Gold; Average Yield of Gold from Quartz crushed in 1891; Average Yield of Gold per Ton of Quartz crushed in each Year of Decade; Average yield of Gold per Ton of Quartz crushed in each Mining District in each Year of Decade; Average Yield of Gold from Quartz and Alluvium; Average Yield from Tailings and Mullock during 1891; Average Yield of Gold from Pyrites in 1891; Average Yield from Washdirt; Average Yield of Gold from Cement; Quantity of Gold received at Mint in 1891; Price of Gold per ounce; Number of Gold-miners; Number of Quartz and Alluvial Miners; Average of Gold produced per Miner; Yield of Gold in Australasian Colonies for 1891; Quantity of Metals other than Gold raised in 1891; Quantity of Silver Extracted from Gold in 1891; Number of Miners employed in Mining for Metals and Minerals of Gold for 1891; Dividends in Mining Districts in 1891; Salaries and Wages in Mining Districts in 1891; Pyrites Works in Victoria in 1891; Smelting Works in Victoria in 1891; Machinery employed in Alluvial Mining in 1891; Machinery employed in Quartz Mining in 1891; Prices Charged per ton for crushing in 1891; Machinery for Economical Crushing; Area of Claims for Gold-mining in 1891; Number of Gold-mining Leases *issued* in 1891; Number of Gold-mining Leases *in force* in 1891; Leases under Mining on Private Property Act in 1891; Number of Mineral Leases *issued* in 1891; Number of Leases *in force* in 1891 for Mining for Metals and Minerals other than Gold; Length of Water-races, &c., in 1891; Revenue from Gold-fields in 1891; Timber consumed for Mining Purposes in 1891; Value of Metals other than Gold exported from Melbourne in 1891; Value of Metals other than Gold imported into Melbourne in 1891; Explosive Compounds imported and exported from Melbourne in 1891; Kerosene Oil imported in 1891; Mining Accidents in 1891; Persons killed in Mining, 1874–1891; Causes of Fatal Accidents; Persons killed in 1891; Persons injured in Mining, 1874–1891; Non-fatal Acci-

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2D. DAVID, T. W. E. Report on the Discovery of *Cinnabar* at Bingara, pp. 234-239, with plan and section.

2E. DAVID, T. W. E. Third Report on the Ironstone Mountain, Port Stephens, pp. 240–244, with plan and section.

2F. DAVID, T. W. E. Report on the Government Diamond-drill Bore for Coal, on the Moorebank Estate, near Liverpool, p. 244.

2G. DAVID, T. W. E. Report *re* Wyee Bore, p. 245.

2H. DAVID, T. W. E. Report on the extended Coal Tunnel of the Newcastle and Stockton Land and Coal Company, at the Sevenmile, Raymond Terrace, pp. 245–246.

2I. DAVID, T. W. E. Progress Report, No. 5, Port Stephens District, pp. 246–248, with sections.

3. ANDERSON, W. Progress Report by Mr. William Anderson, Geological Surveyor, pp. 248–249.

3A. ANDERSON, W., and LEIGH, W. S. Report on newly discovered Caves at Yarrangobilly Creek, pp. 249–252.

3B. ANDERSON, W. Report on the Bendithera Silver-field and Currowan and Brimbermala Gold-field, pp. 252–254.

3D. ANDERSON, W. Report on Water Supply for Broken Hill, pp. 254–259, with map.

4D. ANDERSON, W. Report on Wallah Wallah, pp. 259–260.

4. STONIER, G. A. Progress Report by Mr. G. A. Stonier, Geological Surveyor, pp. 260–261.

4A. STONIER, G. A. Report on the Silver-fields near Inverell, pp. 261–262.

5. JAQUET, J. B. Progress Report by Mr. J. B. Jaquet, Geological Surveyor, p. 262.

6A. HAMMOND, P. T. Report on Cessnock Diamond-drill Bore, pp. 262–264.

6B. HAMMOND, P. T. [Report on Forest Reserve, No. 50 a, Parish of Belford, County Northumberland], pp. 264–267, with map and section.

7. ETHERIDGE, R., JUN. Progress Report of the Palæontologist for 1891, pp. 267–268.

7A. Contributions to the Palæontology of Australasia.

No. 19—Shells from the Kitchen-Middens near Ballina, p. 268.

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7C. No. 21.—Plant Remains from the Bulli Coal-measures, p. 269.

7D. No. 22.—The Discovery of a Skeleton of a Thylacine in the Jenolan Caves, p. 269.

8. ETHERIDGE, R., JUN. Annual Report of the Librarian for Year 1891, p. 270.

8. CARNE, J. E. Report of the Curator and Mineralogist for the Year 1891, pp. 270–272.

8A. CARNE, J. E. Donations to the Mining and Geological Museum during 1891, p. 273.

9. MINGAYE, J. C. H. Progress Report by the Analyst and Assayer, pp. 273–276.

9A. MINGAYE, J. C. H. Report on the Platinum-bearing Minerals of Broken Hill, p. 276.

9B. MINGAYE, J. C. H. Report on Bulk Assays of Platinum-bearing Ores from Broken Hill, p. 277.

9C. MINGAYE, J. C. H. Analyses and Report on Three Samples of Clay, p. 277.

9E. MINGAYE, J. C. H. Analyses and Report on a Sample of Coke manufactured from Coal at the Mount Pleasant Colliery, near Wollongong, p. 278.

9F. MINGAYE, J. C. H. Report and Analysis of a Sample taken from a Fire-brick which had been in use in a Smelting Furnace, p. 279.

9G. MINGAYE, J. C. H. Report on a Qualitative Analysis of Sample No. 298, p. 279.

10. LEIGH, W. S. Progress Report of the Superintendent of Caves, pp. 280–281.

10B. LEIGH, W. S. Report on New Cave, Bungonia Caves, p. 281.

10A. LEIGH, W. S. Report on the newly discovered Caves at Yarrangobilly, pp. 282–283.

VIII. BOULTBEE, J. W. Water Conservation. Report upon the Public Watering-places of the Colony by the Officer-in-Charge, pp. 284–306.

IX. BOULTBEE, J. W. Report on Artesian Boring by the Officer-in-Charge, Water Conservation, pp. 307–322, with sixty-four sections, map, and following Appendices.

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A. MINGAYE, J. C. H. Extract from Report of the Department of Mines for 1886, p. 319.

B. MINGAYE, J. C. H. Report on Analysis of Water from Cuttaburra Bore, p. 320.

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D. Estimated Traffic on the undermentioned Roads upon which it is proposed to Bore, p. 320.

E. MINGAYE, J. C. H. Analysis of Water from Native Dog and Youngerrina Bores, p. 321.

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G. Artesian Well Boring Tools and Plant complete, p. 322.

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2. On the occurrence of *Platinum* "in situ" in N. S. Wales.
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2. RANDS W. H.—Report of the Assistant Government Geologist [Cape River Gold-field; Mount Leyshon; Livingstone Reef; Dreghorn Diggings; Star Beds (Carboniferous); Coal near Noosa; Paradise Gold-field; Cania, with map and sections], pp. 9–13.

3. MAITLAND A. G.—Report of the Assistant Geologist [Magnetic Island; the Upper Burdekin; Coolgarra District; Coal Discoveries at Cooktown], pp. 14–18.

4. JACK R. L.—Geological Map of Commissioner's Hill, Gilberton. To accompany Report on Etheridge and Gilberton Gold-fields. Scale, 4 chs. to 1 in.

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OBITUARY NOTICE. Charles Smith Wilkinson, F.G.S., F.L.S., V.P.L.S., New South Wales. Born 1843, died 23rd August, 1891. *Geol. Mag.*, 1891, VIII (3), pp. 571–573.

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PLATE XIII.

Schizoneura? australis, *Eth. fil.*

Remains of a plant showing three undivided leaves on each side of the stem.

Drawn from nature by Mr. G. H. Barrow, Australian Museum.

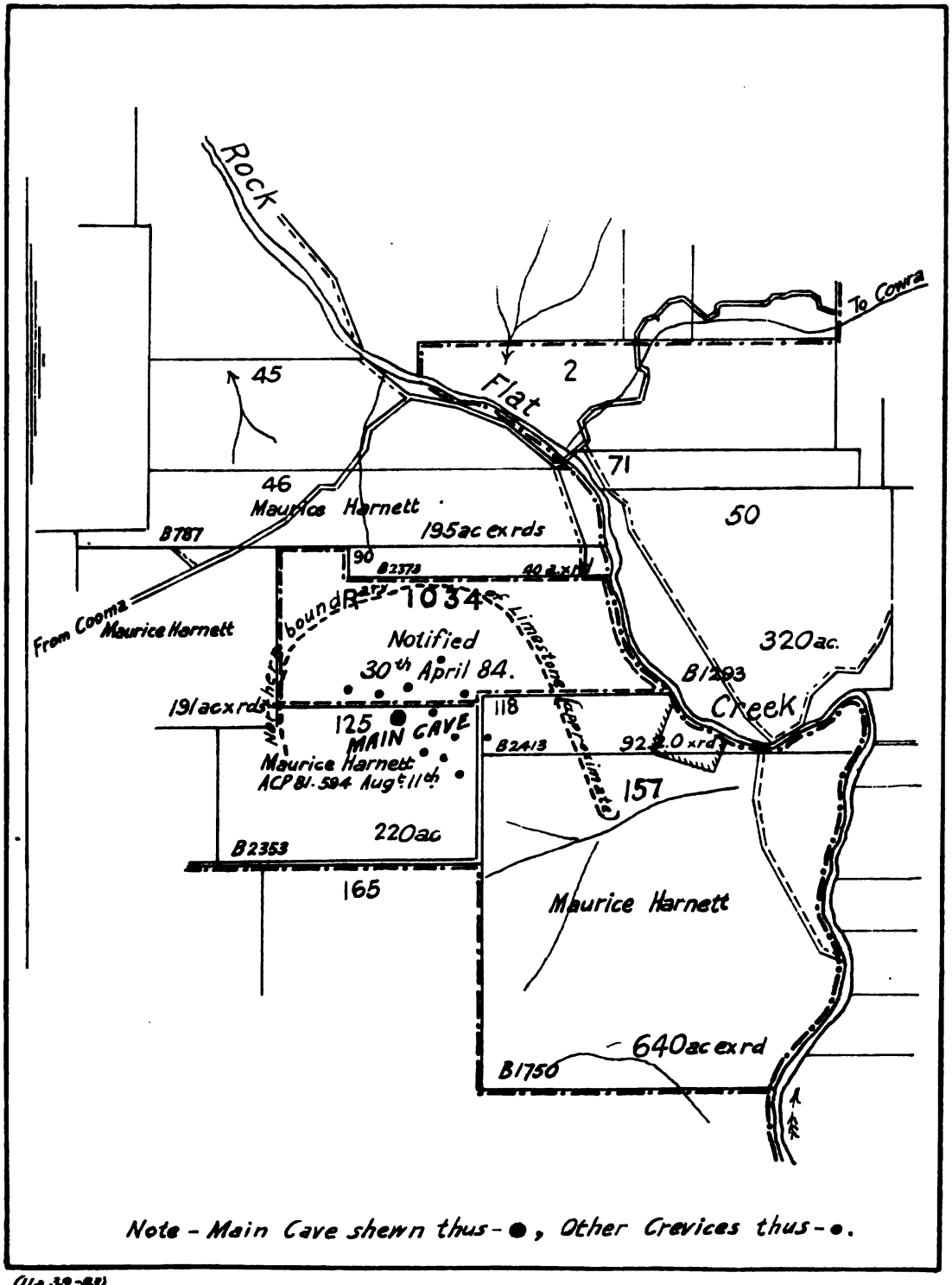
(IIIa 39-93).

PHOTO-LITHOGRAPHED AT THE GOVT. PRINTING OFFICE,
SYDNEY, NEW SOUTH WALES.

PLATE XIV.

Plan of part of the Parish of Woolumla, County Beresford, showing the position of the Rosebrook Caves.

Scale, 40 chains to 1 inch.



Note - Main Cave shewn thus - ●, Other Crevices thus - •.

(11a 39-83).

PHOTO-LITHOGRAPHED AT THE GOVT. PRINTING OFFICE,
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PLATE XV.

Point Piper.

Fig. 1. Large fish, twenty-two feet long, and twelve and a half wide.

Figs. 2–5. Four subordinate small fish, each after a type of its own.

Fig. 6. Circle contiguous to two of the smaller fish.

Fig. 7. Shield with cross-bars and diamond-shaped ends; four and a half feet long.

Fig. 8. Kangaroo, ten feet high, with the hands and one eye well delineated.

Fig. 9. Kangaroo head, contiguous to Fig. 8.

Fig. 10. Fish, seven feet long.

Fig. 11. Male figure, with outstretched bent arms, and eyes, but no mouth.

Hawkesbury.

Fig. 12. Fish over twelve feet long.

Fig. 13. Male figure, with arms extended above the head, and a foot on the left leg.

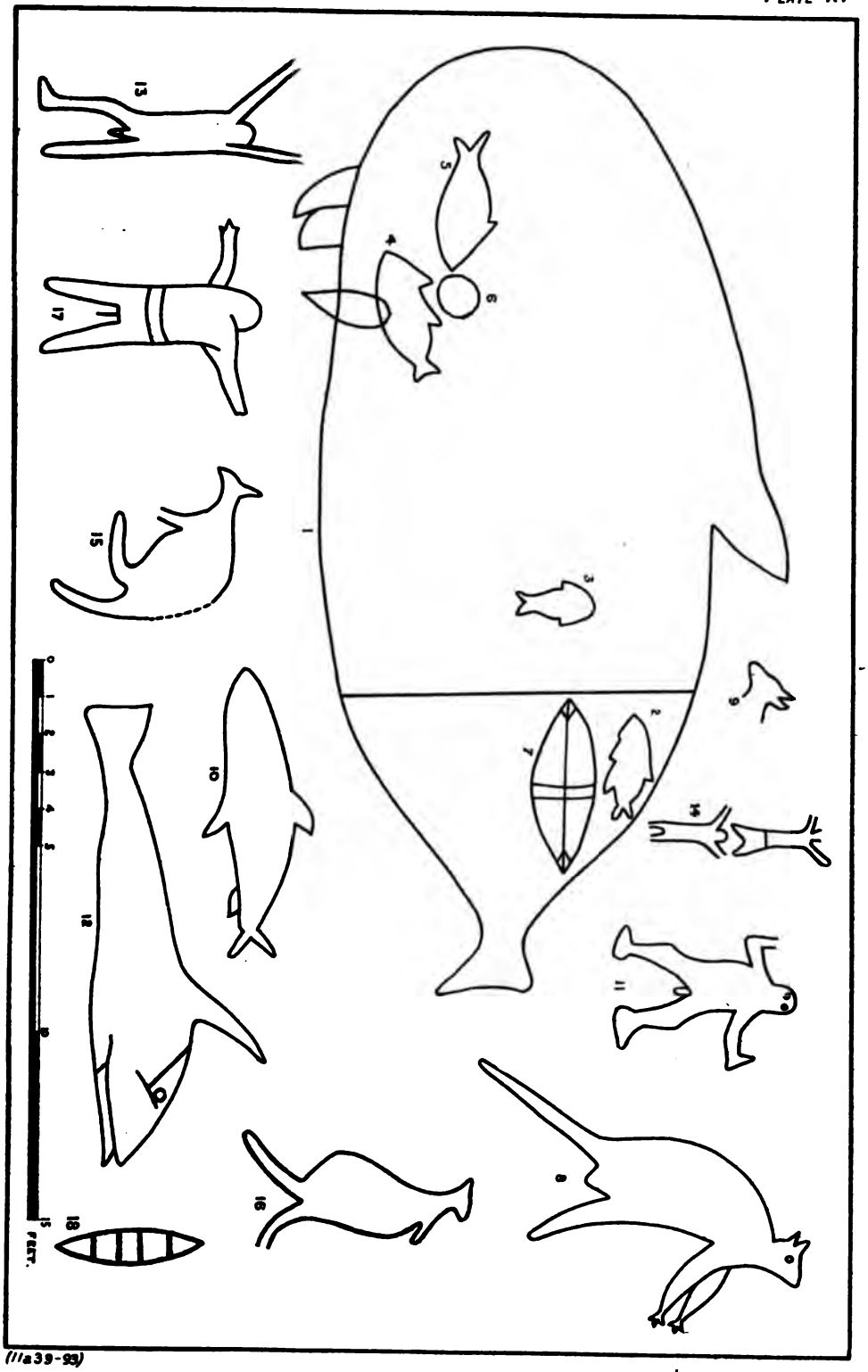
Fig. 14. Two diminutive male figures, supposed to represent boys, in one of the positions in which the initiates were placed during the *Bora*.

Fig. 15. Kangaroo, with the dorsal outline imperfect.

Fig. 16. Kangaroo, with badly executed head.

Fig. 17. Male figure, with the head pressed down on the shoulders, and clothed with the belt of manhood.

Fig. 18. Canoe, with four stretchers.



(IIIa39-93)

DEPARTMENT OF MINES AND AGRICULTURE, SYDNEY.

RECORDS

OF THE

GEOLOGICAL SURVEY OF NEW SOUTH WALES.

CORRIGENDA.

Vol. III, P. 3.

Page 90, line 10—For *prosper*, read *broken*.

considerable quantity, of a mineral that appears black when coarse, and bright green when in thin flakes. When examined closely a large proportion of the smaller grains are seen to consist of transparent green fragments of this mineral. The constituent minerals will be briefly described.

1. *Garnet.*—This mineral constitutes the greater part of the sand. It occurs, chiefly, in grains of a dark red colour, of irregular shape, and varying in size from that of a very small pea down to the finest sand. One large piece occurred, measuring nearly two c.m. in longest diameter. The true nature of this piece was not evident at first sight, owing to a coating of clayey matter, but when broken it was found to consist entirely of granular red garnet. It would therefore seem as if the grains of this mineral had been derived from a rock in which it was an important constituent, if not a true "garnet rock." In only one case were crystal faces noticed, the faces of the rhombic-dodecahedron being just recognisable. One

DEPARTMENT OF MINES AND AGRICULTURE, SYDNEY.

RECORDS

OF THE

GEOLOGICAL SURVEY OF NEW SOUTH WALES.

Vol. III.] 1893. [Part 4.

XX.—On a Sand from Bingara: by GEORGE W. CARD, A.R.S.M., &c., Curator and Mineralogist.

THE following notes relate to a sand submitted for examination to the Geological Survey Branch. The grains of which the sand is composed are small, varying in size from a lentil downwards, and mostly angular. The larger proportion is very fine, thus rendering examination difficult. Owing to the predominance of a red constituent the prevailing colour is red, this being varied by the presence, in considerable quantity, of a mineral that appears black when coarse, and bright green when in thin flakes. When examined closely a large proportion of the smaller grains are seen to consist of transparent green fragments of this mineral. The constituent minerals will be briefly described.

1. *Garnet.*—This mineral constitutes the greater part of the sand. It occurs, chiefly, in grains of a dark red colour, of irregular shape, and varying in size from that of a very small pea down to the finest sand. One large piece occurred, measuring nearly two c.m. in longest diameter. The true nature of this piece was not evident at first sight, owing to a coating of clayey matter, but when broken it was found to consist entirely of granular red garnet. It would therefore seem as if the grains of this mineral had been derived from a rock in which it was an important constituent, if not a true "garnet rock." In only one case were crystal faces noticed, the faces of the rhombic-dodecahedron being just recognisable. One

or two of the grains were pitted and roughened, a few well rounded, while by far the greater number were irregular in shape with sharp edges and a conchoidal fracture :—

Colour :—Varies from deep red—almost black—to various shades of pink and red-brown.

Lustre :—Good, except in the case of the roughened grains, the well rounded particles approaching zircon in this respect.

Streak :—Almost or quite colourless.

Hardness :—Between 7 and 8—considerably below topaz.

Tenacity :—Brittle, thin splinters being readily obtainable.

Fusibility :—Very readily fused to a black globule, magnetic when crushed.

Specific-Gravity :—Satisfactory specific-gravity results were very difficult to obtain, owing to the small size of the particles. Using the Joly Balance, and weighing a number of grains together, the average result of a number of experiments was 3·88.

Blow-pipe Reactions :—Soluble in borax with iron reactions.

Almandine would appear to be the principal, or only variety present.

2. *Spinelle.*—When commencing the examination of the material, several grains resembling garnet were obtained which appeared to be infusible, and were therefore regarded as spinelle. No such grains having been found in a further supply of the sand, although a large number have been tested, the occurence of this mineral must be considered doubtful.

3. *Mineral allied to Pyroxene.*—Next in abundance to garnet is a mineral opaque and black when of any thickness, but transparent and clear green when in thin chips. This is the dark constituent referred to in the general description of the sand, the red mineral being garnet. It occurs in irregular fragments, varying in size from grains a little larger than the larger garnets down to very small flakes. These latter are very numerous, and can be readily produced by crushing the larger fragments, which are very brittle. The larger pieces are traversed by numerous surface cracks, which are filled with a light-coloured clayey substance:—

Fracture :—Sub-conchoidal, giving rise to moderately sharp edges, where the particles become translucent.

Streak :—A very pale buff.

Hardness :—About 7.

Cleavage :—Cleavage-faces are occasionally present.

Lustre :—From slightly resinous to vitreous on the fractured surfaces.

Specific Gravity :—As in the case of the garnets very difficult to obtain, approximately 3·4 (Joly).

Fusibility:—Easily fused to a black non-magnetic globule.

Blow-pipe reactions:—Soluble in borax; an insoluble skeleton in microcosmic salt.

Solubility in Acid:—Doubtfully attacked by strong HCl.; the acid appeared only to clean the grains by removing the ferruginous colouring material.

Optical Properties:—When mounted in Canada balsam and examined between crossed nicols the thin flakes are found to be doubly refracting, and to possess a moderately high refractive index.

In the absence of suitable appliances no further optical investigation could be made.

No chemical analysis having been made as yet, the mineral may perhaps be placed in the neighbourhood of augite.

4. *Zircon.*—Occurs in the form of small, highly refracting grains. These are either colourless or slightly tinged with brown. They are generally very perfectly rounded, frequently in grains of a cordate form. Not seldom a number of crystal facets were observed, the edges being sharply defined and the faces perfectly plane. The longer edges of the facets are parallel, and although, in the absence of goniometers, and on account of the small size of the crystals, the crystalline form cannot be accurately made out, a powerful lens is sufficient to distinguish the appearance they present from the characteristic octahedral forms assumed by the diamond. There should, therefore, be no difficulty in distinguishing the zircons from diamonds if two or three crystal-facets are present:—

Specific Gravity:—By using a very sensitive spring an attempt was made to obtain a specific-gravity result with the Joly Balance. A result of 4 was obtained but this can only be regarded as extremely approximate.

Hardness:—Well below 8, being readily rubbed down by topaz—but above 7.*

5. *Magnetite.*—This mineral ranks next to zircon in point of relative abundance. A considerable quantity can be readily separated with a magnet. The grains are mostly small in size and differ much in appearance. Many well cleaved† fragments occur. These generally have parallel faces and a high metallic lustre; others are irregular in form and sometimes exhibit the pimply surface characteristic of magnetite; one mammillated piece occurred. The grains are mostly coated to a greater or less extent with ferric oxide, which fact may perhaps account for the somewhat low specific gravity of 4·6 which was obtained for a number of grains taken together.

* This affords a ready means of discrimination from diamond. As the grains are much too small to be held between the fingers, and too much rounded to be held by forceps, the usual method of dealing with small fragments must be followed, viz., attaching to a slip of glass or some similar support by means of a powerful cement. In one instance an apparent cleavage face was obtained by fracturing.

† It is probable that these are not true cleavage face, but planes of separation due to lamellar twinning.

One perfect crystal occurred. This crystal, which had a length of about one millimetre, consisted of the rhombic-dodecahedron modified by faces of the octahedron. The faces of the former were very strongly striated—the striation almost amounting to grooving—as a result of oscillatory combination; the crystal very strongly resembling in this respect, on a small scale, the magnetite sometimes obtained from Nordmarken, in Sweden. Another much less perfect, but apparently similar crystal was found.

6. *Ilmenite.*—Not so abundant as magnetite. Some of the metallic-looking fragments with parallel cleavage, occurring in the sand, are magnetic and also yield feeble titanium reactions. Many of the ilmenite grains are rounded in form, with one cleavage face. The rounded surface is dulled and weathered; the cleavage face bright and metallic, often characteristically striated. The usual blow-pipe reactions are given.

7. *Rutile.*—This mineral is fairly common. It occurs in elongated forms, the length being much greater than the diameter; occasionally also in the form of small cleaved fragments. The fractured ends exhibit a brilliant lustre. The elongated forms, although somewhat rounded, still retain what are possibly indications of crystal edges. In every case the rutile fragments are black and opaque. The streak is grey, and titanium reactions are readily obtainable by the blow-pipe.

8. *Quartz.*—Only abundant in the finest portion of the sand. Several large fragments occurred; of these, some are transparent and colourless with conchoidal fracture and sharp edges, others are dull and rounded and occasionally iron-stained.

9. *Chalcedony and Jasper.*—Some very small fragments of milky chalcedony, reddish jasper, &c., were noticed in the fine material obtained by sifting.

10. *Hematite and Limonite.*—Several large irregularly shaped fragments of dark coloured hematite, and of limonite, with many small grains.

11. *Calcite.*—One colourless fragment of fibrous calcite.

12. *Clay.*—In the form of yellowish nodules. While examining the sifted portion microscopically a few scoriaceous particles were observed; also some composite fragments, the components being black and shining, and red and opaque, respectively.

Numbers 3, 5, 6 and 7, are not always readily distinguishable at first sight. The pyroxenic constituent breaks up into transparent green flakes when crushed; the magnetite and ilmenite yield a black metallic, and the rutile a grey powder when similarly treated. The garnets have been locally taken for ruby, but may, of course, be at once distinguished by their inferior hardness and their fusibility before the blow-pipe.

At present corundum—including ruby and sapphire—tin-stone, brookite, topaz tourmaline, &c., have not been detected.

Having regard to the difference in the character of the quartz grains and the occurrence of a fragment of garnet rock, and of magnetite and ilmenite, it would appear probable that the sand has been divided from the degradation of more than one description of rock.

XXI.—On the Occurrence of *Trigonia semiundulata*, McCoy, in New South Wales, and its significance: by R. ETHERIDGE, Junr., Palæontologist and Librarian.

MARINE FOSSILS of Tertiary age have not hitherto been described from within the geographical boundaries of New South Wales. The Rev. W. B. Clarke* mentioned "Shelly Deposits" in the "far Western interior, beyond the Darling," which he believed to be Tertiary. In the First Edition of the Geological Map of New South Wales†, Mr. C. S. Wilkinson represented a large area of Tertiary rocks in the south-western corner of the Colony, extending from the South Australian boundary up the courses of the Rivers Darling and Lachlan, and along those of the Rivers Murrumbidgee and Murray as far east as one hundred and forty-six and a half east longitude. Later‡ he remarked "The Middle and Upper Miocene marine-beds appear in the banks of the Murray River, on the south-western border of the Colony. They doubtless extend under the Riverina Plains, where they are covered by the Post Pliocene alluvial deposits . . . . . we have no trace of them along our sea board." More recently still he referred to the subject in his "Report on the prospects of obtaining Fresh Water below the surface, in the Districts between the Rivers Lachlan and Darling, and beyond the River Darling," before the Royal Commission on Conservation of Water§, in the following words,—"No. 3. Miocene.—This formation is only seen in the banks of the Lower Darling; but there is little doubt that it extends under No. 2 deposits [Pleistocene and Pliocene], which forms the level country south by a line drawn from Booligal on the Lachlan to Menindie on the Darling, thence west to the South Australian Border." Again Mr. Wilkinson remarked‖ "Area, twenty-two thousand square miles."

Amongst several bores sunk by means of Water-augurs, in the angle formed by the junction of the Murray and Darling Rivers, under the superintendence of

* Sedimentary Forms, N.S. Wales. Third Edition, 1875, p. 51; Ibid, Fourth Edition, 1824, p. 94.
† Ann. Report Dept. Mines of N.S. Wales for 1880 (1881).
‡ Notes on the Geology of N.S. Wales, 1882, p. 56.
§ N.S. Wales Royal Commission Conservation of Water. First Report, 1885, Pt. 2 (Minutes of Evidence), p. 46
‖ *Ibid*, p. 47.

Mr. J. W. Boultbee, Officer-in-charge of the Public Watering Places Branch of the Department of Mines and Agriculture of New South Wales, that at Arumpo, east of the Darling, in the County of Wentworth, is the only one that has yielded any decipherable traces of organic remains. In this bore a *Trigonia*, and another small bivalve, were brought up from a depth of about six hundred and forty-seven feet.

According to Professor R. Tate,* the fossiliferous Murray Tertiaries disappear at Overland Corner, on the River Murray, sixty miles in a direct line from the boundary between New South Wales and South Australia, or one hundred and forty-three miles by the river windings, under cliffs of sand and clay, the two sets of beds being slightly unconformable to one another. On the one hand, we have, to the west, Sturt's fossiliferous formation,† the marine Calciferous Sandstone of Tate, and on the other, to the east, the before mentioned cliffs of sand and clay, also observed by Sturt in his memorable boat voyage down the Murray. Two miles to the east of Overland Corner, Tate describes the following section:—‡

Reddish sands, about	10	feet.
Dirty yellow or greenish sharp sands	10	„
Coarse quartzose, sand-rock, &c....	15	„
Grey, angular, coarse sand	30	„
Hard calcareous sand-rock, with a few Older Tertiary fossils	5	„
	70	„

Professor Tate remarks on this section that it is instructive, "as it is the only one known to me in which the actual superposition of the sharp fluviatile sands upon the marine beds is visible." The fluviatile sands of this section constitute Professor Tate's Newer Tertiary, and the marine beds his Older Tertiary. It is the former set of strata which extends into New South Wales as the formation next in downward succession to the surface Post Tertiary (?) deposits, for Tate adds—"Doubtlessly the whole of the depressed area about the Lower Darling is constituted of Newer Tertiary."§

The older division is now separated by the same Author into the Upper and Lower Murravian Series. The fauna of the former is not copious, principally the "ubiquitous oyster," and amongst other fossils, *Trigonia acuticostata*, McCoy, a shell distinct from that found in the Arumpo Bore. These Newer Tertiaries are believed by Tate to be of Miocene age. The Lower Murravian Series was formerly separated by Tate into two sub-divisions, but it is now regarded by him as one, and possibly homotaxial with the Lower Eocene of European geologists. Its fauna is a very abundant one, and is more or less generally represented by that of the

* Trans. R. Soc. S. Australia for 1883-84 [1885], VII, p. 26.
† Two Exped. Int. S. Australia, Years 1828-31, II, 1834, p. 139.
‡ Trans. R. Soc. S. Australia for 1883-84 [1885], VII, p. 42.
§ Ibid. p. 43.

lower beds at Muddy Creek, Spring Creek, Corio Bay, and Schnapper Point in Victoria, as well as the Table Cape beds in Tasmania.* At most of these localities our Arumpo Bore *Trigonia* is met with.

Applying the above data to the occurrence of this shell in the Arumpo Bore, there appears to be presumptive evidence that we have an extension of the Lower Murravian beds into New South Wales below the Newer Tertiary and Post Tertiaries of the Murray-Lower Darling area. Similar beds in Victoria, are termed by Mr. R. A. F. Murray, Miocene,† and he says that they have recently been proved by boring operations in search of water, "to exist beneath the great plains of the North Western district," *i.e.*, that portion of North-west Victoria, south of the River Murray.

The *Trigonia* now under consideration is *T. semiundulata*, McCoy, and consists of the centre half of a right valve, about the size, or perhaps a little less than one of McCoy's figured examples.‡ It displays a portion of the dorsal margin, posterior slope, and nine radiating costæ instead of ten or eleven, leaving a portion of the slope immediately under the dorsal margin occupied by other semi-obliterated much finer ribs. The concentric rippled rugæ are well marked, and immediately anterior to the siphonal ridge, broken up into almost quadrangular nodes. The siphonal ridge is by far the strongest and widest of the costæ. Internally a portion of the large tooth is preserved.

It appears to me that the radiating costæ on the posterior slope were granulated or toothed, and on comparing an exceedingly well preserved example from Muddy Creek, I find them to be distinctly so. McCoy in his orginal description,§ says that the costæ of the posterior slope are "crossed by lines of growth near the margin, closer and spinulose near the beak." Now, the shell from Muddy Creek proves that the whole of the ribs of the posterior slopes are densely denticulated from the umbones to the posterior margins, and the denticles posteriorly curved, so that when looked at from above they appear as truncated nodes. Furthermore, the concentric undulating rugæ are said to be crossed except on the anterior end, "by rather faint impressed sulci radiating from the beak to the ventral margin." But in the specimens examined by me, these are not sulci, nor are they continuous, but rather a fimbriation of the lower margin of each concentric ruga, and these being placed directly under and above one another in line, give rise to the appearance of sulci, until closely examined.

* Journ R. Soc. N. S. Wales for 1888 [1889], XXII, p. 242.
† Victoria—Geol. and Phys. Geography, 1887, p. 104.
‡ Prod. Pal. Vict., Dec. II, 1875 t. 19, f. 5.
§ Geol. Mag., 1866, III, p. 481.

XXII.—On the Occurrence of Basalt-glass (Tachylyte) at Bulladelah: By G. A. STONIER, F.G.S., Geological Surveyor.

IN 1887, Professor (then Mr. Geological Surveyor) David announced the discovery of Tachylyte in New South Wales, while engaged in a geological survey of the Vegetable Creek District*. Subsequent to the description of this rock, Mr. Black, of Wallangra near Inverell, sent a specimen of Tachylyte to the late Mr. C. S. Wilkinson, Government Geologist, and it has also been found to occur both at Carcoar and Cowra.†

The specimen, to which the following remarks apply, was collected in the Port Stephens District two years ago, although there has not been an opportunity hitherto of examining the microscope slide.

At Bulladelah a large deposit of alunite occurs forming the summit of a prominent hill behind the township; a considerable tonnage of mineral has been quarried, some of which was treated locally, and the remainder was shipped to England. The Tachylyte was found at the southern extremity, and at the foot of the hill, with several loose fragments of andesitic pitchstone, mostly about three inches, one block, however, being twelve inches in diameter. Time did not permit of their being traced to the place whence they have been derived, although the parent rock cannot be far distant. The rocks in the locality are both sedimentary and eruptive; the former are probable referable to the Carboniferous System, but the latter have not been investigated.

In hand specimens the rock appears to be compact, but when examined with a fairly powerful lens, small gas pores can be detected. The colour of freshly broken surfaces is black with a resinous lustre inclining to vitreous; joint faces are bluish-black, occasionally iridescent. The fracture is sub-conchoidal. Thin splinters fuse readily to an opaque black bead, and the powdered rock is very feebly magnetic. Two determinations of the specific gravity were made with a Walker's Balance, and found to be respectively 3·16 and 3·17. The average density of Tachylyte is about 2·7, but is variable as the following figures show§ :—

Iceland—2·53, sideromelane.

Sasebühl—2·58, tachylyte.

Sandwich Islands—2·71, basalt glass (six varieties).

Beal (Western Islands, Scotland)—2·72, basalt glass.

Some do do 2·89, do

* Proc. Linn. Soc. N.S. Wales, 1887, II, (2), p. 1078.
† J. Milne Curran, Journ. R. Soc., N.S. Wales, 1891, XXV, p. 200.
§ Judd & Cole, Quart. Journ. Geol. Soc., 1883 XXXIX, p. 449.

All the specimens examined had a specific gravity markedly lower than the Bulladelah example, and it is possible that the latter may be a glassy form of an ultrabasic rock.

Under the microscope the principal constituent is an isotropic glass, fairly translucent and containing globulites, microlites, and skeleton crystals. By transmitted light the glass is seen to have been originally of a dull slightly yellowish-brown colour, due perhaps to dusty magnetite, which has been abstracted in parts to help to form microlites, &c., and in those places the colour is a clear yellow. If the quarter-inch objective be used, a sub-perlitic structure is discernible, due to a number of fine cracks, some of which are curved and concentric. Gas pores are fairly numerous and of various sizes up to four-tenths of a millimetre in diameter. The microlites are peculiar and exceptional. They are very abundant, and under a low power seem to be all black and opaque. The most noticeable are long spicular bodies, slightly translucent at their extremities; they run in various directions, intersecting each other at various angles, and are generally surrounded by a rather indistinct absorption halo. Besides the long microlites there are others of a similar character although of a shorter habit, which are collected into aggregates having a parallel arrangement, but making various angles with the longer axis of the crystal they are commencing to form. Rosenbusch has figured a similar example*, and considers them to be hornblende microlites. Distinct from those which have already been referred to, are some minute crystals and grains arranged in straight lines so as to form rods, which intersect each other at right angles and give various figures, from a simple cross to more complex forms. These are composed of magnetite, and in places show a good dendritic structure. Spherulites and trichites are not represented, nor are there any porphyritic minerals. Under a high power clouds of globulites appear, and the crystallizations are seen to be varied; the long spicules are made up of a number of small microlites frequently simulating a quiver of arrows, while on their sides are fern-like excrescences. The absorption halos also become more distinct.

The above description represents the general character of the slide, but in one portion there are clear microlites distributed through a greyish-black ground mass and surrounded by a ring of greyish-black and colourless microlites crossing each other in various directions, with an outside setting of long spicular hornblendes having a roughly radial arrangement.

The pitchstone shows both well developed fluxion and perlitic structure, with a fair sprinkling of allogenic crystals of triclinic felspar and corroded fragments of andesitic lava.

* Vol. I, pl. III, fig. 3.

XXIII.—On Palatal Remains of *Palorchestes azael*, Owen, from the Wellington Caves Bone-deposit: by W. S. DUN, Assistant Palæontologist and Librarian.

[Plate XVI.]

I.—Introduction.

THE type specimen of the genus *Palorchestes* was discovered in 1851 by Dr. Ludwig Becker, in Pleistocene deposits in Victoria, and was described by the late Sir Richard Owen*. This specimen consisted of the anterior portion of the cranium with the five cheek-teeth *in situ*. In the 'British Museum Catalogue of Fossil Mammals,'† Mr. R. Lydekker mentions a "cast of the palatal region of the cranium, showing the five cheek-teeth of either side" (M. 2,573), as presented by Professor Ramsay‡. This specimen was found in the Wellington Caves, and another cast of this fossil is in the Mining and Geological Museum, Sydney, mention of which will be made later on. The specimen about to be described was found in the Wellington Caves, by Mr. James Sibbald, the Keeper, who is most energetic in his search for remains, and has already succeeded in unearthing a large number, some of which it is hoped will be reviewed later on. The specimen in question was found in 1891 in the bone bed of No. 4 Cave. This cave, Mr. W. S. Leigh, Superintendent of Caves, informs me, is on practically the same level as others from which previous supplies of Marsupial remains have been obtained, and is a small chamber leading off from the larger caves. As far as I can ascertain, these—the British Museum, Australian Museum, and Geological Survey Collection specimens—are the only cranial examples of *Palorchestes* that have as yet been found, though deposits of the same age in Queensland have yielded specimens of the mandibles, and other portions of the skeleton, which from their relative size seem to be more nearly allied to *Palorchestes* than to any other known Macropod. A list of these specimens and references to their literature will be found in the British Museum Catalogue,§ and Mr. C. W. De Vis has recorded a specimen of the jaw of *Palorchestes* from St. Ruth, Darling Downs, Queensland.‖

II.—Description of the Specimen.

Our specimen consists of a portion of the palatal region of the cranium showing nearly all the bony palate and the hinder two-thirds of the maxillaries, with the premolar, p^4, the first three molars on each side *in situ*, and the anterior half of the alveoli of the right and left fourth molars. The teeth are in a singularly good state of preservation, as is usually the case with specimens from the Wellington Caves bone-breccia, being much more perfect than in the type specimen from

* Phil. Trans. R. Soc., 1874, CLXIV, pls. 81, 82, 83; Phil. Trans. R. Soc., 1876, CLXVI, pl. 20; Extinct Mam. Austr., pl. 97, fig. 1; Proc. R. Soc.; 1873, XXI; 1875, XXIII.

† Pt. V, p. 238.

‡ Dr. E. P. Ramsay, Curator, Australian Museum, Sydney.

§ *Op. cit.*, p. 238, and *inter alia*, pp. 239, 241, 242, 244, 245.

‖ Proc. Linn. Soc. N. S. Wales, 1883, VIII, Pt. 2, p. 221.

Victoria. The maxillary suture is well marked and comparatively simple. The palato-maxillary sutures are clearly marked and more complex. In this specimen the palatines reach a point nearly opposite to the anterior border of m^3, whereas in the type specimen they extend to about the middle of the same tooth. The lateral anterior angles of the suture are rounded, and the palatines narrow slightly posteriorly, whereas in *Macropus* the anterior lateral angles are projected forward or straight, and the palatines increase slightly, instead of narrowing, towards their posterior margin. The palatines likewise appear to have apertures in them at the anterior angles, as is the case with existing species of *Macropus*. Unfortunately, the posterior margin of the palate is imperfect, but it would appear to be slightly concave. Opposite the premolars are the openings of two vascular foramina in the maxillaries, directed backwards. The cheek teeth form an open curve which widens posteriorly. Portion of the maxillary pier of the right zygomatic arch is preserved, and agrees with the description of that part in the type specimen. On the cranial surface traces of the narial septum are preserved, disappearing at a point about opposite to the roots of m^1. The "blind fossa" mentioned by Sir Richard Owen is well preserved.

Premolar, P^1.—This tooth is triangularly-ovate in shape, the apex being directed inwards. It is divided into two portions, an outer and an inner, by a longitudinal depression. The outer ridge which is the more largely developed of the two is composed of two lobes, an anterior and a posterior, connected by a narrow mid-link. The working surface is small and more marked on the fore part. The left premolar, though it presents the same general form as the right, does not show its division into anterior and posterior lobes so clearly. On the outer aspect there is a well-marked groove separating these two portions, and it is also developed on the inner slope. On the anterior face there is a well-marked groove running towards the crown and ending in a depression, and a fainter one on the anterior curve. The prebasal ridge is continued to the anterior angle of the inner lobe. There is also a well-marked post-basal ridge which commences about one-third up the posterior lateral angle of the outer lobe and is continued to the posterior angle of the inner lobe. The sulcus dividing these two lobes is well marked, and is bounded before and behind by the pre- and post-basal ridges. The two lobes are connected to about two-thirds of their height. The crown of the inner lobe is worn into a narrow elongated surface parallel to the curve of the molar series. There are two roots, the hinder is large and oblong ovate, tapering slightly and in the same plane as the posterior face of the tooth, and slightly hollowed down the median line. The anterior root is much smaller, tapering down to a point, and is directed slightly forwards. The enamelled surface is smooth and not corrugated. The following measurements give the relative proportions of the right premolar—length, 21·5 mm.; breadth, 19 mm.; length of outer lobe without ridges, 17 mm.; length of inner lobe without ridges, 14 mm.

First Molar, M^1.—The first molar has two well-marked lobes, an anterior and a posterior. In form it is oblong-ovate. Dividing the teeth in two along the main valley it will be seen that the anterior lobe is slightly the larger, and has a well-developed pre-basal ridge extending from the median line round the inner anterior angle of the tooth, and has a width of 2·5 mm. At the outer corner there is the commencement of the outer half of the pre-basal ridge, which runs out almost immediately in consequence of a strongly-marked hollow in the enamel. The margins of this depression form an island, which is almost surrounded by a thin band of cement continuous with the worn surface of the fore-lobe. Connecting the anterior and posterior lobes is a mid-link. The outer half of the main valley slopes up gradually to the mid-link, and the outer enamel is constricted to form an oval depression three mm. long. The inner portion of the main valley is directed slightly forwards at the mid-link, and is divided into two portions and an outer and an inner by a ridge on the sides of the anterior and posterior lobes; the inner portion is considerably deeper than the outer. At its inner and outer aspects the main valley is bounded by a slight elevation of the enamel, more especially marked on the inner. The post-basal ridge is well marked. There is a slight groove along the median line of the posterior lobe. Measurements of right first molar—length, 27·5 mm.; breadth, 22 mm.

Second Molar, M^2.—This tooth, as will be seen from the measurements, is slightly larger than m^1, and is more simple in structure. The fore-lobe is slightly the wider. There is a well-marked pre-basal ridge commencing at the anterior outer angle and continuous round the inner curve of the fore-lobe, being interrupted in the median line by a ridge running up to the working surface. As in m^1 the inner half of this ridge is the more marked. The front slope of the tooth bears slight traces of ridging. The mid-link is well marked, and the main valley is of the same nature as in the preceding tooth. There is a well-marked tubercle at the outer margin of the main valley. The post-basal ridge is not so well marked as in the preceding tooth, and is confined to the outer half of the posterior aspect of the tooth. There is a median groove as in m^1, and on the inner side of it there is a bulging of the tooth more marked than in m^1. Length, 28·5 mm.; breadth, 23·5 mm.

Third Molar, M^3.—This tooth is more elongate and slightly narrower than m^3. The general form is of the same type as in m^3. The pre-basal ridge is not so marked on the outer side, and the mid-link is placed at a lower level, due to the less worn state of the anterior and posterior lobes. The tubercle at the outer opening of the main valley is more marked than in the preceding tooth, and the ridge on the sides of the inner portion of the main valley, which are so well marked in m^1 and m^2, are absent. The post-basal ridge is still less developed, and is confined to the outer half of the hinder aspect of the posterior lobe. Length of tooth, 29 mm.; breath, 23 mm.

The following is a tabular comparison of the relative proportions of the three specimens already mentioned—that described by Sir Richard Owen in the Philosophical Transactions for 1874, the specimen from the Wellington Caves, now first recorded, and a cast of another specimen from the Wellington Caves in the possession of the Australian Museum :—

	Owen's Type.*	Wellington Cave Specimen.	Australian Museum Specimen (cast.)
Length of molar series p^4 to m^4	120·5	.....	123·5
Length of p^4 to m^3	92·5	106·5	96
Length of p^4	19	21·5	18·5
,, m^1	22	27·5	24
,, m^2	25·5	28·5	26·5
,, m^3	26	29	27
,, m^4	28	.....	27·5
Palate, breadth outside m^3	102	106·5	103
Palate, breadth outside m^2	59·5	57	57
Palate, breadth outside p^4	77	82·5	79
Palate, breadth inside p^4	54	47·5	46·5

III.—Conclusions.

The general condition of the teeth is, as before remarked, very well preserved and their appearance would lead one to infer that they belonged to an aged animal, though their relatively little worn condition would point to the fact that m^4 had not long come into position. Certainly it is not represented in the specimens, but the remains of the alveolus shows that it had been cut. As pointed out by Mr. Lydekker pm^4 resembles that of *Sthenurus*—with which he regards *Protemnodon* to be synonymous, and has accordingly classed *Protemnodon anak*, Owen, under *Sthenurus atlas*, Owen†,—in possessing an inner lobe, and wearing to an oval surface, and having no marked secant edge. The surface enamel of the molars resembles that of *Sthenurus* also in that it is not folded, a point in which *Palorchestes* differs from *Procoptodon*. In *Sthenurus* the connecting link between the fore and hind lobes of the molars is not well marked as is pointed out by Mr. Lydekker, and shown in the plate‡ in the 'Fossil Mammals of Australia,' and in the figure§ in the British Museum Catalogue. In our specimen of *Palorchestes* this, however, is well marked as will be seen by the figure. The pre-basal ridge or talon in *Sthenurus* has no bridge connecting it with the forelobe whereas in our specimen there is. In the British Museum Catalogue it is stated that "the true molars have no distinct anterior talon"‖, and a little further on, "in the absence of an anterior talon, the upper true molars resemble those of the existing *Macropus magnus*," but these statements seem hardly borne out by the specimens before us, as both the examples

* Measurements taken from 'Fossil Mammals of Australia,' pl. XCVII, fig. 1. All measurements in millimetres.

† *See* footnote, B. M. Cat. Foss Mam., V, pp. 231 and 232.

‡ Pl. 83, f. 8.

§ Vol. V., f. 37.

‖ *Op cit.*, p. 237

from Wellington Caves and the figure of Owen's type show one, though certainly not marked to a large degree as in the case of *Macropus brehus*, Owen (*Sthenurus brehus*, Owen*).

Sir Richard Owen considered that *Palorchestes* occupied a position between the existing *Macropodidæ* and *Nototherium* and *Diprotodon*†. Mr. C. W. De Vis‡ is of opinion that this genus is more nearly allied to *Sthenurus* than to *Macropus* or *Procoptodon*. From a consideration of the relative differences of the upper premolar and molars it would seem to resemble *Sthenurus* in the form of the premolar, while the molars possess characters in common with *Macropus brehus*, Owen (as defined in the British Museum Catalogue), and *Procoptodon*. It must be pointed out that, in the plate, lines are shown on the outer and inner surfaces of the molars, these are meant to represent cracks in the enamel alone and not ridging or grooving.

XXIV.—Mineralogical and Petrological Notes—No. 1: by GEORGE W. CARD, A.R.S.M., &c., Curator and Mineralogist.

I.—Contents.

1. Haloid Silver minerals from Peak Hill.
2. Crystallised Pyrite from Mount Stewart.
3. [Spadaite] from Marulan District.
4. Inclusion of Mispickel in Quartz; 4A Doubly-terminated crystals of Quartz; 4B. Rock Crystal from Kingsgate, with a note by E. C. Whittell, Field Assistant.
5. Chocolate nickel ore from New Caledonia.
6. Quartz Felsite containing crystals of Mispickel from Sunny Corner.
7. Volcanic Glass from Tweed River District.

II.—Introduction.

Many specimens of minerals and rocks are submitted to the Geological Survey Branch for examination, or are added to the collections in the Mining and Geological Museum. It must necessarily be the case that points of interest arise from time

* Extinct Mam. Australia, pl. 109, f. 4, and B. M. Cat. Foss. Mam., V, pp. 207, 208.
† Extinct Mam. Australia, p. 470.
‡ *Loc. cit.*, p. 224.

to time, and it is now proposed to record these in the form of brief Mineralogical and Petrological Notes. Nothing like a complete description will be attempted under this heading, but the occurrence will be recorded, and such leading particulars given as may be useful to persons engaged in the mining industries of the Colony, and to others interested in geology. It is hoped to continue the "Notes" at frequent intervals.

III.—Mineralogical Notes.

1. *Haloid Silver Minerals from Peak Hill.*—Early in the present year specimens of auriferous ore were received from the Welcome Mine, Peak Hill, in which these minerals were present in considerable quantity.

The ore is of the brecciated character usual in this district, the silver minerals being present in the form of a thin greenish-yellow coat. A number of tests were made with the blow-pipe with the result that bromine was detected in considerable quantity in examining one piece of the ore, but in every subsequent experiment only iodine could be found. A qualitative analysis showed that the silver was present principally as chloride, but that some iodide also occurred; no bromine was detected. An assay yielded 20½ oz. of gold, and 140 oz. of silver.

The analysis and assay were made under the superintendence of Mr. J. C. H. Mingaye, the Analyst and Assayer.

2. *Crystallised Pyrite from Mount Stewart.*—An exceptionally fine specimen of crystallised iron-pyrites has recently been added to the Mining and Geological Museum by the favour of the Mount Stewart Lead-and Silver-mining Company. The block is very massive, and measures fourteen by eighteen inches. The crystals consist principally of very perfect cubes, which are not modified by faces of other forms. Every dimension of cube, up to 1¼ inch edge, occurs: the faces frequently exhibit the striations characteristic of this mineral, interpenetration—twinning is rare, and a curious etching is present on some of the faces. The faces of the pentagonal-dodecahedron occurs but rarely, and always imperfectly developed. A few quartz crystals with a long prismatic habit occur on one side of the specimen, and in druses. Unfortunately some of the crystal edges have been damaged by a fall in the mine.

3. [*Spadaite.*]—A clay, resembling in character the substance described* by Dana as spadaite, from the Marulan District. It is a soft flesh-coloured, non-plastic substance with a soapy feel and imperfectly conchoidal fracture, occurring in nodules in a brownish soapy clay which is traversed by veins of oxide of manganese. It is slightly waxy in colour, and adheres but little to the tongue. In water it rapidly falls to pieces with copious liberation of air-bubbles, but does not make a paste; heated in the blow-pipe flame, it does not decrepitate, but fuses readily with much

*E. S. Dana, A System of Mineralogy. Sixth edition, 1892, p. 682.

intumescence to a glass varying from colourless to green; when first fusing it glows brilliantly, sometimes with a slight fluorescence; no colouration is obtained with nitrate of cobalt. Heated moderately in a crucible it becomes brittle, but without change of colour. It easily gelatinises in hydrochloric acid, and yields much water in the glass tube. Hardness, about 2. A qualitative analysis, made by the Analyst and Assayer, gave the following results:—Soluble in hydrochloric acid; consists of a hydrated silicate of iron, alumina, and magnesia, with a small quantity of manganese probably existing as MnO.*

4. *Inclusion of Mispickel in Quartz.*—From the Kingsgate Mines, near Glen Innes. The best specimen is a portion of a fairly large crystal of quartz. Two prism-faces are preserved, the width being about fifty millimetres (two inches), and the transverse striations very distinct. The crystal is otherwise every much broken. It is tolerably clear internally, but discoloured on the outer surface.

The inclusions of mispickel occur in one portion of the crystal, and are in ribbon-like form. In one case it forms a sort of axis with projections on one side, but the greater part is arranged in a radiating manner from a central nucleus. The radiating filaments may either be drawn out approximately in the direction of the principal axis of the quartz crystal, or are twisted in various directions. Here and there the inclusions emerge on a surface of fracture, and sufficient material can be obtained to determine the presence of arsenic and iron.

4A. *Doubly-terminated Crystals of Quartz.*—Also from Kingsgate. One large and several smaller crystals have been obtained. The large specimen has the following dimensions:—Total length three hundred millimetres (eleven and a half inches); length of prism one hundred and sixty millimetres (six and a quarter inches); length of each termination about seventy millimetres (two and a half inches); diameter of crystal from the centre of one prism-face to another about one hundred millimetres (four inches). The development of the rhombohedral faces is not very unequal. Oscillatory combination is very strongly marked, both on the prism- and the rhombohedron-faces, the edges of the prisms more especially, being very irregular in consequence. The crystal is dull externally and nearly opaque; internal reflections giving rise to prismatic colours on the faces of R. Both the apices are slightly damaged. The smaller specimens are each about sixty-four millimetres in length. One of them has a tabular habit owing to the great development of certain faces. All are translucent, and two are somewhat smoky.

4B. *Rock-Crystal from Kingsgate.*—A considerable quantity of rock-crystal has been obtained. Some of the smaller pieces were perfectly clear, and would probably be quite good enough for optical work were they a little larger. Most

* The presence of manganese might be accounted for by the occurrence of the veins mentioned above.

of the larger blocks, although very clear, display the prismatic colours produced by internal reflection resulting from internal cracks; in some cases this was only a surface feature, but in others the interior was affected, the specimens being thus rendered unfit for the manufacture of "pebble" glasses.

Not much rock crystal is used in the Colony, but a small quantity is imported; it remains to be proved whether this demand might not be locally supplied.

The specimens from Kingsgate, just described, were brought down by Mr. E. C. Whittell, who has kindly supplied me with the following information regarding their mode of occurrence. "The quartz and rock-crystals were obtained from the Old Kingsgate Bismuth Mine, about twenty-two miles north-west from Glen Innes, from what appeared to be pipe-veins . . . and segregated irregular masses—some of considerable extent—in granite. Some of the workings seemed to yield little else but rock crystal; tons of this material being at grass. In mining, the crystals, with but few exceptions, had been broken considerably, so that I was unable to procure any of large size. Much of the mineral seems to be of good quality for spectacles, &c. Those specimens containing inclusions of arsenical pyrites . . . were of rare occurrence and were to be found in those heaps which consisted chiefly of quartz and rock-crystal."

5. *Chocolate Nickel Ore, from New Caledonia.*—Specimens of this ore have lately been received from New Caledonia, and are now in the Geological and Mining Museum. Several of the specimens contain the green as well as the brown variety of the ore. These are associated in such a way as to suggest a passage from one to the other. In one case it would appear as if the green mineral had undergone such a change, as residual patches of it remain surrounded by the brown.

Two assays and qualitative analyses were made under the supervision of the Assayer and Analyst, with the following results:—

1. Chocolate nickel ore from a depth of 100 metres. Mine Bienvenue, Nakety.

Protoxide of nickel	19·37	per cent.
Equal to metallic nickel	15·23	„

2. Chocolate nickel ore, Mine La Renaissance.

Protoxide of nickel	18·50	per cent.
Equal to metallic nickel	14·55	„

On qualitative analysis "these minerals were found to consist largely of ferric oxide, magnesia, nickel oxide, silica, and a small percentage of chrome iron ore."

6. *Quartz-Felsite containing crystals of Mispickel, from Sunny Corner.*—This is a pale greenish rock mottled with white where undergoing kaolinisation. It is very compact.

Many very perfect little crystals of mispickel are embedded in the rock. These have an average length of 1·5 millimetres, and occur singly for the most part, but are sometimes arranged in stellate and in cruciform twin-groups. The readiness with which the crystals of mispickel become detached from the rock renders the preparation of a thin section very difficult, but Mr. C. Murton, the Lapidary, has succeeded in producing a slice transparent enough for microscopic investigation. The rock is found to consist of a hemi-crystalline groundmass in which fragments of quartz, none of which are idiomorphic, are contained. In the thicker portions of the section what appears to be a true flow structure may be seen, but where thinner the groundmass can be resolved into the minutely granular polarising areas characteristic of quartz-felsite. The rock would appear to be a somewhat devitrified acid eruptive mass. An assay by the Analyst and Assayer yielded three ounces of silver and three penny-weights of gold.

7. *Volcanic Glass from the Tweed River District.*—An acid volcanic glass, in which many porphyritic crystals of quartz and felspar occur, has been several times brought in with a view to its containing tinstone. The mistake arose from the unusual brownish-red colour assumed by the quartz when weathered, and was by no means an unnatural one. Here and there the doubly-terminated crystals of quartz are to be seen very clearly.

A special point of interest arises from the glassy nature of the magma, a vast number of crystallites, globulites, margarites, clavalites*, &c., being developed.

Perlitic structure is beautifully shown on the weathered surfaces, the weathering resulting in the production of spheroidal masses. This, and other similar rocks from the same locality will be fully described and illustrated at an early date. This rock should prove of considerable utility for educational purposes.

XXV.—Note on an Aboriginal Skull from a Cave at Bungonia: by R. ETHERIDGE, Junr., Palæontologist and Librarian.

SOME time ago a human skull was found under peculiar circumstances, by Mr. Louis Guymer, Keeper of the Bungonia Caves, in a small cave, about four hundred yards in a northerly direction from the top of the "Look-down," at Bungonia. The skull was ultimately transmitted to the Department through the Superintendent of Caves (Mr. W. S. Leigh).

* F. Rutley, Min. Mag., 1891, IX, p. 263.

The Bungonia Caves are situated in the Parish of Inverary, County of Argyle, about thirteen miles from Marulan and twenty-four from Goulburn. "The Look-down is on the top of the out-crop of the limestone in which the caves occur, and from this position a magnificently picturesque view is obtained, looking into the Shoalhaven Valley at its junction with the Jerrara Creek, where there is almost a sheer drop of over of a thousand feet, the precipice being formed by the lime-stone, which dips towards the main valley"*

About twenty feet within the mouth of the cave, says Mr. Guymer, there is a drop of ten feet, then a small chamber, with the floor dust covered. Twelve feet within this chamber in a westerly direction was observed a large overhanging rock, and under this the skull was found. It rested on a skin of some kind, then rotten with age, face downwards, and was immediately covered with a net. This was over-lain by some stringy-bark, and above the whole flat stones were piled. No other human bones were discovered, but a number of smaller ones, probably wallaby. The position of the skull was at least forty feet under ground in a direct line. The cave is said to have been years ago, the haunt of bushrangers.

As the occurrence of this skull, under the circumstances cited, and supposing it to have been aboriginal, opened up certain interesting traits in the character of the blacks, it was of importance to ascertain to which of the two races now inhabiting the country it appertained. With this in view the specimen was placed in the hands of Prof. J. T. Wilson, M.D., of Sydney University, who has very kindly supplied the following measurements:—

Cubic capacity	... cubic centim.	1,233
Longitudinal cranial diameter (glabello-occipital)	m.m.	173
Transverse maximum diameter (in parietal region)	„	121
Vertical diameter (basi-bregmatic)	„	126
Cephalic index		70
Total horizontal circumference	m.m.	473
Vertical transverse arc (supra-auricular)...	„	277
Bizygomatic width	„	109
Ophryo-alveolar height	„	66
Facial index		60
Narial height	m.m.	38
„ width	„	24
Narial index		63
Orbital height	m.m.	32
„ width	„	35
Orbital index (megaseme)		91
Facial angle (with Broca's Facial-lateral Goniometer)		83°
Projection of anterior cranium, total	m.m.	87
„ „ facial	„	4
„ of posterior cranium	„	93

* Anderson, Ann. Report, Dept. Mines, N. S. Wales for 1889 [1890], p. 232.

The skull is that of an aboriginal child, and says Prof. Wilson, characteristically Australian, about eight years of age, the first permanent molars present, and the permanent lateral incisors just appearing. It is markedly dolichocephalic and strongly platyrhine. The sex is doubtful.

The foregoing details amply prove the skull to be that of a young aboriginal, and this is well borne out by its surroundings in the cave—the net, bark, and stones. Very little notice need be taken of the presence of bushrangers at one period, for it is exceedingly unlikely that they would have exercised the same care and attention to detail as that shown by those who placed the skull in the cave. The use of bark and stones in disposing of human remains amongst the Aborigines has been repeatedly described, and as regards the net, a portion of which I have examined, there can be no possible doubt of its aboriginal origin. It consists of a two-ply string made of fibre, and stained dark brownish-red. The mesh is a very loose one, each loop crescentric-triangular, an excellent illustration being that given by the late Mr. R. B. Smyth, in his work on 'The Aborigines of Victoria,' of a hand fishing-net from Lake Tyers, Gippsland.* It was known to the Lake Tyers natives under the name of *Lowrn*, and is likewise identical with the mesh of a Tasmanian "basket or bag" preserved in the Oxford University Museum.† It is the same stitch as that used at the present day in ladies fancy work, and is technically known as the "plain net or first lace stitch."

Now the chief interest attached to the discovery of this skull centres itself in the well known dread of caves exhibited by the Aborigines, a dread even handed down to the half-castes. Unless under very exceptional circumstances few Australian blacks can be induced to enter one of these places, and we can only come to the conclusion therefore, that this occurrence is one of those exceptions. Another point requiring solution is—why was the skull only placed there, to the exclusion of other parts of the body, more particularly in connection with the manifest care bestowed on it?

Touching the reluctance of the blacks to enter caves we have the testimony of Henderson, who states in his 'Observations on the Colonies of New South Wales and Van Diemen's Land,'‡ that around Wellington (New South Wales), "the natives entertain a superstitious dread of entering any of the caves in the limestone rock." Again, our leading authority on all matters aboriginal, Mr. A. W. Howitt, in describing his exploration of the Mitchell River, in North Gippsland, mentions the wonderment of his sable companions, Turnmile and Bungil-Bottle, at the stalactite caverns on Dead-cock Creek, regarded by them as the "haunt of the mysterious creature, the 'nargun,' the 'nargun a narguna', or 'den of the nargun.'"§ During a recent examination of the Cooleman Caves,

* Aborigines of Victoria, 1878, I, p. 389, f. 223.
† Ling Roth, Aborigines of Tasmania, 1890, p. x, f. 3.
‡ P. 150 (8vo. Calcutta, 1832).
§ Progress Report Geol. Survey Victoria for 1875 [1876], p. 220.

on Cooleman Creek, at the head waters of the Goodradigbee River, by Mr. R. A. Barber, of Humewood, Yass, Mr. W. S. Leigh, Superintendent of Caves, and the Writer, nothing would induce our half-caste guide, Dick Low, to enter the caves with us. By the Watchendie Tribe, at Shark's Bay, Western Australia, all caves are looked upon as the abode of malevolent spirits called *Ingnas*, the souls of departed blacks, who have not received the correct rites of sepulchre, and are shunned as much as possible.* Mr. A. Oldfield, the writer of the previous passage, adds, "Nearly every cave gives a shelter to an *Ingna* of the ordinary kind, and such places are only resorted to during violent thunder-storms, and then merely to hide themselves from the fury of a spirit more dreaded than those haunting such localities." Guided by these facts it would appear that the dread of entering caves, although widely spread, was not absolutely universal amongst the Aborigines—for Howitt's companions do not seem to have entertained fear. We can only conclude that the presence of this skull in the Bungonia Cave points to the depositers as an illustration of the exceptions to the rule, for the evidence, such as it is, seems to indicate the surroundings of the skull as aboriginal. It must not be inferred that any connection whatever is intended between caves in the strict sense of the word, and the *Gibber-gunyahs*, or Rock-shelters, and invariably exposed to the light of day. The use of these is well known and thoroughly understood—that of places of habitation.

Mr. W. W. Froggatt, when collecting at Kimberley, N. W. Australia, observed the habits of the blacks of that region. He says† "They build no mi-mis, as they obtain complete shelter in the numerous limestone caves," that is, in the cave entrances, for Mr. Froggatt tells me they will on no account penetrate beyond, into the inner recesses.

An authenticated case of a black taking to a cave is that of the mummified remains discovered in one of the inner-chambers of the Mosquito Plains Caves, near Mount Gambier, South Australia, and recorded by the late Rev. J. E. T. Woods‡. It appears this man was a survivor from a "dispersal," and being wounded crept further and further into the cave to die, where the corpse became "almost petrified by the droppings of the limestone." It was known to have been in that position for many years.

The only other instance known to me of human remains found in an Australian cave is the mention by the late Mr. Gerard Krefft§, of "bones of the extremities found in a cave at Wellington, being left and right femur, left and right tibia, left and right humerus, portion of fibula." These were found in No 2 Cave at

* A. Oldfield, Trans. Ethnol. Soc., 1865, III, p. 236.
† Proc. Linn. Soc. N.S. Wales, 1888, III (2), p. 651.
‡ Geol. Obs. S. Australia, 1862, p. 329.
§ Australian Vertebrata (Recent and Fossil), &c., 1867, p. 91.

Wellington, by Mr. Henry Barnes, Articulator, &c., to the Australian Museum, Sydney, and were those of a "gin." The bones were not petrified, and appeared to have been casually washed in from the surface.*

It would seem, therefore, definite evidence to the contrary being absent, that this is a genuine case of the deposition of aboriginal remains sufficiently far within a cave to be an exception to the general rule previously referred to.

XXVI.—The Australian Geological Record for the Year 1892, with Addenda for the Year 1891: by R. ETHERIDGE, Junr., Palæontologist and Librarian, and W. S. DUN, Assistant Palæontologist and Librarian.

I.—Record for 1892.

ANDERSON (W.):—

Progress Report by Mr. William Anderson, Geological Surveyor. *Ann. Rept. Dept. Mines and Agric. N. S. Wales for* 1892, pp. 121–125, with map and section.

Geological Map of part of the Elrington (Major's Creek) Gold-field. Scale, 10 chains to 1 inch. *Ann. Rept. Dept. Mines and Agric. N. S. Wales for* 1892.

On the General Geology of the South Coast, with Petrological Notes on the Intrusive Granites, and their Associated Rocks, around Moruya, Mount Dromedary, and Cobargo. *Records Geol. Survey N. S. Wales*, 1892, II, Pt. 4, pp. 141–165, pls. 8–10.

Notes on the Occurrence of Opal in New South Wales. *Records Geol. Survey N. S. Wales*, 1892, III, Pt. 1, pp. 29–32.

ALADDIN'S LAMP CLAIM, LUCKNOW.—The Aladdin's Lamp Claim, Lucknow. *Austr. Mining Standard*, 1892, VII, No. 189, p. 365.

AUSTRALIA—HANDBOOK—The Australian Handbook [Gordon and Gotch], &c., for 1892. [The Phys. Structure and Geology of Australia, pp. 116–119; N. S. Wales, Mining, pp. 150–151; Victoria, Geology, p. 228; Mining, pp. 232–233; S. Australia, Geology, pp. 312–313; Mineral Resources, p. 316; Northern Territory, Mineral Resources, pp. 353–354; Physical Geography, pp. 355–356; Geological Formation, pp. 357–359; W. Australia, Geology,

* See a discussion of this subject—Etheridge, Proc. Linn. Soc. N.S. Wales, 1890, V (2), p. 204.

p. 368; Mineral Resources, pp. 369–370; Queensland, Geology, p. 389; Mineral Resources, p. 392; Tasmania, Geology, p. 441; Mineral Resources, pp. 443–444.]

AUSTRALIA—YEAR BOOK—The Year Book of Australia for 1892. Edited by E. GREVILLE. [Annual Mineral Review, pp. 195–214.] 8vo. Sydney, 1892.

BATAVIA RIVER—The Batavia River Gold Rush. Its position and worth. *Austr. Mining Standard*, 1892, III, No. 213, pp. 335–336.

BEECHWORTH SLUICING—Sluicing at Beechworth (Vic.). *Austr. Mining Standard*, 1892, VII, No. 172, p. 110.

BENDIGO MINES—The Bendigo Mines. *Austr. Mining Standard*, 1892, VIII, No. 199, pp. 128–129; No. 201, p. 157; No. 202, pp. 169–170; No. 203, p. 190.

BERTRAND (C.-Eg.) and RENAULT (B.)—*Pila bibractensis* et le Boghead d'Autun, pp. 95, pls. 2 (8vo. Autun, 1892.) [*Reinschia australis*, C.-E.B. and B.R., and Kerosene Shale of N. S. Wales.]

BITTNER (.)—Uber Echiniden des Tertiars von Australien. *Sitzungsb. K. K. Akad. Wien*, 1892, Marz., *Abth.* 1.

BLACK HORSE UNITED MINE, EGERTON—The Black Horse United Mine, Egerton (Vic.). *Austr. Mining Standard*, 1892, VIII, No. 196, pp. 77–78.

BOULTBEE (J. W.)—Report on Artesian Boring. *N. S. Wales Parl. Paper*, 457—A. Pp. 17, map and section. Folio, Sydney, 1892. By Authority.

BOXALL, (G. E.)—The Barrier Range Silver-field, Australia. *Engineering and Mining Journal*, 1892, LIV. No. 15, p. 340.

BRADSHAW (J.)—Notes on a Recent Trip to Prince Regent's River. *Trans. R. Geogr. Soc. Austr. (Vict. Branch)*, 1892, IX, Pt. 2, pp. 90–102. [Geology, p. 100.]

BRIGHT DISTRICT MINES—The Bright District Mines. *Austr. Mining Standard*, 1892, VII, No. 173, p. 126; No. 174, p. 136; No. 175, p. 159; No. 178, p. 203.

BROKEN HILL BLOCK 10—The Broken Hill Block 10. *Austr. Mining Standard*, 1892, VII, No. 177, pp. 190–191.

BROKEN HILL MINERALS—Broken Hill Minerals. Mr. E. W. Aldridge's Collection. *Austr. Mining Standard*, 1892, VII, No. 186, p. 324; No. 187, p. 339.

BROKEN HILL MINES:—

The Broken Hill Mines. *Austr. Mining Standard*, 1892, VII, No. 180, p. 239.

The Broken Hill Mines. Copper and Gold. *Austr. Mining Standard*, 1892, VIII, No. 216, p. 380.

BROWN (H. Y. L.)—Report on Country in the Neighbourhood of Lake Eyre. *S. A. Parl. Papers*, 1892. Maps and Sections. Folio, Adelaide, 1892. By Authority.

BURTHANDRA GOLD MINE—The Burthandra Gold Mine (N.S.W.) *Austr. Mining Standard*, 1892, No. 173, p. 128.

BUTCHER'S REEF CO., MARYBOROUGH.—The Butcher's Reef Company, N.L., Maryborough (Vic.). *Austr. Mining Standard*, 1892, VIII, No. 216, p. 380.

CARNE (J. E.):—

Progress Report by Mr. J. E. Carne, Geological Surveyor. *Ann. Rept. Dept. Mines and Agric. N. S. Wales for* 1892, pp. 145–147.

[Report on Iron Deposits at Lithgow, Newbridge, Blaney, and Lyndhurst.] *Ann. Rept. Dept. Mines and Agric. N. S. Wales for* 1892, pp. 147–151, with plan.

Report on the Chrome Iron Ore Deposits near Coolac, in the Parish of Gobarralong, County Harden, and Darbalara, County Buccleugh. *Ann. Rept. Dept. Mines and Agric. N. S. Wales for* 1892, pp. 153-159, with map.

CHANDLER'S CREEK—Chandler's Creek Amalgamated. *Austr. Mining Standard*, 1892, VIII, No. 201, p. 160.

CHARTER'S TOWERS GOLD-FIELD—Centres of Mining throughout the World. No. 1, Charters Towers and its Gold-fields. *Mining Journal*, 1892, LXII, No. 2971, pp. 843–845.

CLARKE (A. W.):—

Petrological Notes on two Samples of Rock from British New Guinea, collected by Sir William MacGregor, K.C.M.G. *Thomson's British New Guinea*, 1892, App., p. 205.

Notes on Sand and Gravel, Sudest River, collected by Sir William MacGregor, K.C.M.C. *Thomson's British New Guinea*, 1892, App., p. 205.

CROOINJEE—A Neglected Field. *Austr. Mining Standard*, 1892, VII, No. 185, p. 309.

CROYDON GOLD-FIELD—The Croydon (North Queensland) Gold Field. *Mining Journal*, 1892, LXII, No. 2972, pp. 879–880.

CRUSHED DOG GOLD MINE—The Crushed Dog Gold Mine. *Austr. Mining Standard*, 1892, VIII, No. 192, p. 22.

DALMORTON GOLD-FIELD—The Dalmorton Gold Field (N.S.W.) *Austr. Mining Standard*, 1892, VIII, No. 212, p. 319; No. 213, p. 338.

DAVID (T. W. E.)—Report on Kerosene Shale Deposits, Doughboy Hollow, near Murrurundi. *Ann. Rept. Dept. Mines and Agric. N. S. Wales for* 1892, pp. 159–167, with map.

DAVIS H. L.—The Oriental Mine, Withersfield Gem District (Queensland). *Austr. Mining Standard*, 1892, VIII, No. 195, p. 62.

DE MAULETTE (P.)—Essai d'une Synthèse géométrique des Faits géogéniques observés en Australie, fondée sur une Nouvelle Interprétation du Réseau pentagonal. *Revue Univ. des Mines*, XII, p. 1. [Fide *Annuaire Géologique*, 1891 [1892], VIII, Fasc. 1, p. 74.]

DENISON TOWN, N.S.W.—Prospecting in the Tertiary Drifts at Denison Town, N.S.W. *Austr. Mining Standard*, 1892, VII, No. 189, p. 371.

DOUGHBOY SHALE PROPERTY—The Doughboy Shale Property. *Austr. Mining Standard*, 1892, VII, No. 169, p. 9.

DUN (W. S.)—Notes on the Teeth known as *Sceparnodon Ramsayi*, Owen (*Phascolonus gigas*, Lydekker). *Records Geol. Survey N. S. Wales*, 1892, III, Pt. 1, pp. 25–29, pl. 6

DUNN (E. J.)—Notes on the Glacial Conglomerate, Wild Duck Creek. *Dept. Mines Vict., Special Reports*, 1892, pp. 5, map, plates, &c. Folio, Melbourne, 1892. By Authority.

EAST (J. J.)—Report of the Curator of the Museum [of the South Australian School of Mines and Industries and Technological Museum], with Descriptions and Catalogue ef the Principal Exhibits. *Ann. Report S. Austr. School Mines, &c.*, for 1891 [1892], pp. 109–167.

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EL DORADO MINE—The El Dorado Mine (Vic.). *Austr. Mining Standard*, 1892, VII, No. 170, p. 80; No. 171, p. 97.

EMMAVILLE MINES—The Emmaville Mines. The Mount Galena Silver and Lead Mine. *Austr. Mining Standard*, 1892, VII, No. 183, p. 278.

ETHERIDGE (R., Junr.)—

Annual Report of the Palæontologist for the Year 1892. *Ann. Rept. Dept. Mines and Agric. N. S. Wales for* 1892, pp. 171–173.

Annual Report of the Librarian for the Year 1892. *Ann. Rept. Dept. Mines and Agric. N. S. Wales for* 1892, pp. 173–174.

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XXVII.—A Locality Index to the Reports of the Geological Survey of N. S. Wales from 1875 to 1892 inclusive: by W. S. DUN, Assistant Palæontologist and Librarian.

THE Reports of the Officers of the Geological Survey Branch of the Department of Mines, New South Wales, appear in the Annual Report of the Department.* With the view of facilitating ready reference to the localities mentioned therein, the Compiler has prepared the following Locality Index to the Reports from 1875 to 1892, inclusive.

The system adopted is the following:—First, the name of the locality is given; second, the initials of the Author of the Report; third, the year *for* which the Report is published; and fourth, the page on which the information is to be found.

It must be borne in mind that these Annual Reports contain Reports on work done in a given year and are published in the next, *e.g.* the Annual Report for 1875 bears the publication date of 1876, and so on.

I.—Initials used.

C.S.W.—The late Charles Smith Wilkinson, Geological Surveyor in Charge.

E.F.P.—Edward Fisher Pittman, formerly Geological Surveyor, then Chief Mining Surveyor, now Government Geologist.

T.W.E.D.—Tannet William Edgeworth David, formerly Geological Surveyor, now Professor of Geology and Natural History, University of Sydney.

H.Y.L.B.—Henry York Lyell Brown, formerly Geological Surveyor, now Government Geologist, South Australia.

L.H.G.Y.—The late Lamont Henry Græme Young, formerly Geological Surveyor.

W.A.—William Anderson, late Geological Surveyor.

R.E.—Robert Etheridge, Junr., Palæontologist and Librarian.

J.E.C.—Joseph Edward Carne, formerly Curator and Mineralogist, now Geological Surveyor.

G.A.S.—George Alfred Stonier, formerly Field Assistant, now Geological Surveyor.

J.B.J.—John Blockley Jaquet, Geological Surveyor.

J.C.H.M.—John Charles Henderson Mingaye, Analyst and Assayer.

W.S.L.—Walter Smith Leigh, Superintendent of Caves.

P.T.H.—Percy Thomas Hammond, Field Assistant.

*From 1875 to 1890, under the title of Annual Report of the Department of Mines, New South Wales; since that date, Annual Report of the Department of Mines and Agriculture, New South Wales.

To these may be added:—

H.W.—Harrie Wood, J.P., Under Secretary for Mines and Agriculture.

H.B.S.—H. B. Sullivan, Chief Mining Surveyor.

W.H.J.S.—W. H. J. Slee, Chief Inspector of Mines and Superintendent of Drills.

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TARELLA—J.B.J., 1892, p. 140.
TARRAWINGIE—W.A., 1891, p. 255.
TASMANIA—J.C.H.M., 1890, p. 307.
TATHRA—W.A., 1890, p. 263.
TEMI—T.W.E.D., 1892, p. 159.
TEMORA:—
L.H.G.Y., 1880, p. 263.
C.S.W., 1881, p. 132.
TEMORA GOLD-FIELD—C.S.W., 1881, p. 132, 136.
TEMORA, UPPER—C.S.W., 1881, p. 137.
TENILBA—T.W.E.D., 1889, p. 227.
TEN-MILE CREEK—W.A., 1890, p. 261.
TEN-MILE RIDGE:—
C.S.W., 1885, p. 128.
T.W.E.D., 1889, p. 214.
TENTERFIELD:—
E.F.P., 1879, p. 226.
H.Y.L.B., 1882, p. 149.
T.W.E.D., 1886, p. 159.
TENT HILL—C.S.W., 1883, p. 149; 1884, p. 148.
TERALBA:—
C.S.W., 1877, p. 197; 1884, p. 148.
T.W.E.D., 1888, p. 166.
THACKARINGA:—
C.S.W., 1887, p. 141.
W.A., 1891, p. 254.
THE BROTHERS—G.A.S., 1891, p. 232.
THE GAP—E.F.P., 1883, p. 159.
THE GORGE:—
C.S.W., 1884, p. 147.
W.A., 1891, pp. 254, 258.
THE PINCH—P.T.H., 1891, p. 263.
THE VALLEY—C.S.W., 1882, p. 139.
THORNLEY—T.W.E.D., 1887, p. 152.
THREE-MILE CREEK—W.A., 1886, p. 165.
TIGEROO—H.Y.L.B., 1882, p. 141.
TIBOOBURRA—C.S.W., 1887, p. 137.
TILBA TILBA LAKE:—
W.A., 1890, pp. 264, 265.
J.C.H.M., 1891, p. 275.
TIMBARRA:—
H.Y.L.B., 1882, p. 149.
C.S.W. and W.H.J.S., 1889, pp. 201, 202.

TINGHA—C.S.W., 1883, p. 152.
TIRABEENBAH MOUNTAIN—W.B.C., 1884, p. 156.
TI-TREE CREEK:—
W.A., 1888, p. 182.
T.W.E.D., 1891, p. 222.
TOLL'S GAP—T.W.E.D., 1889, p. 213.
TOMAREE—T.W.E.D., 1889, p. 227.
TOMERONG—T.W.E.D. and G.A.S., 1890, p. 253.
TOMINGLEY:—
C.S.W., 1885, p. 128.
T.W.E.D., 1889, pp. 214, 216.
W.A., 1890, pp. 261, 262.
TOMINGLEY CREEK—C.S.W., 1885, p. 129.
TOOGONG—E.F.P., 1881, p. 140.
TOOLOOM—C.S.W. and W.H.J.S., 1889, p. 201.
TOOLOOM RANGE—C.S W. and W.H.J.S., 1889, p. 201.
TORRYBURN—R.E., 1889, p. 240.
TOWNSHIP HILL—W.A., 1886, p. 166.
TRANGIE—W.A., 1890, p. 261.
TRANGIE PLAINS—C.S.W., 1887, pp. 138, 139.
TROFFS—R.E., 1887, p. 167.
TROLLOPE SWAMP—T.W.E.D., 1884, p. 153.
TRUNKEY—
C.S.W., 1877, pp. 205, 206; 1878, p. 149.
R.E., 1891, p. 268.
TRUNKEY CREEK—C.S.W., 1877, p. 205.
TUENA—C.S.W., 1877, p. 205.
TURLINGAH—L.H.G.Y., 1879, p. 224.
TUMBARUMBA—W.A, 1889, p. 230; 1890, pp. 266, 267.
TURON—C.S.W., 1886, p. 139.
TURON GOLD-FIELD—C.S.W., 1876, p. 175.
TUROSS RIVER—L.H.G.Y., 1879, p. 224.
TWEED HEADS—E.F.P., 1880, p. 245.
TWEED RIVER—E.F.P., 1880, p. 247.
TWEEDY'S FLAT—C.S.W., 1876, p. 164.
TWOFOLD BAY—E.F.P., 1880, p. 244.
TWO-MILE CREEK—T.W.E.D., 1887, p. 150.
TWO-MILE FLAT—C.S.W., 1886, p. 138.
TWO-MILE GULLY—C.S.W. and W.H.J.S., 1889, p. 201.
ULLADULLA:—
C.S.W., 1885, p. 131; 1890, p. 202.
T.W.E D. and G.A.S., 1890, p. 254.

UMBERUMBERKA CREEK—W.A., 1891, p. 255.
UPPER MUSWELL CREEK—T.W.E.D., 1886, p. 145.
URALLA:—
C.S.W., 1878, p. 153.
E.F.P., 1879, p. 226.
T.W.E.D., 1886, pp. 153, 154, 155, 158.
VEGETABLE CREEK:—
C.S.W., 1883, p. 148.
T.W.E.D., 1883, pp. 155, 156, 157; 1884, p. 153; 1891, pp, 229, 234.
VIOLET CREEK—T.W.E.D., 1886, p. 159.
WAGGA WAGGA—C.S.W., 1876, p. 153.
WAGONGA RIVER—W.A., 1890, p. 265.
WALCHA:—
E F.P., 1879, p. 225.
T.W.E.D., 1886, p. 156.
G.A.S., 1892, p. 127.
WALDEGRAVE—H.Y.L.B., 1882, p. 140.
WALFORD'S GULLY—C.S.W., 1886, p. 135.
WALLABY GULLY—T.W.E.D., 1886, pp. 153, 155.
WALLABY ROCKS—C.S.W., 1886, p. 139.
WALLADILLY CREEK.—C.S.W., 1881, p. 137.
WALLAGA LAKE—W.A., 1890, p. 265.
WALLARAH—T.W.E.D., 1888, pp. 166, 167.
WALLBROOK—C.S.W., 1877, p. 201.
WALLAH WALLAH—W.A., 1891, pp. 259, 260.
WALLERAWANG:—
C.S.W., 1875, p. 116; 1891, pp. 212, 213; 1891, p. 215.
T.W.E.D., 1891, p. 213.
WALLI—T.W.E.D. and G.A.S., 1890, p. 239.
WALLIS' CREEK—T.W.E.D., 1887, p. 151.
WAMPA—H.Y.L.B., 1881, p. 144.
WANDAWANDIAN CREEK:—
C.S.W., 1890, pp. 202, 263.
T.W.E.D. and G.A.S., 1890, pp. 250, 253, 254.
WAUGOOLA—T.W.E.D. and G.A.S., 1890, p. 239.
WANKEROO—C.S.W., 1887, pp. 138, 142.
WARDELL:—
C.S.W. and W.H.J.S., 1889, p. 203.
T.W.E.D., 1891, pp. 221, 222, 224, 228.
WARD'S RIVER—T.W.E.D., 1889, pp. 219, 221, 224.
WARRADERY RANGE.—C.S.W., 1876, p. 159.
WARRAH—C.S.W., 1878, p. 153.

WARRAWEENA—T.W.E.D., 1890, p. 243.
WARRELL :—
C.S.W., 1880, p. 240.
L.H.G.Y., 1880, p. 251.
WARREN—C.S.W., 1887, p. 139.
WARRUMBUNGLE MOUNTAIN—R.E., 1887, p. 165 ; 1888, p. 190.
WATTLE FLAT—C.S.W., 1879, p. 214.
WEANDRE CREEK—W.A., 1888, p. 183.
WEAR'S CREEK—C.S.W., 1885, p. 135.
WEEDEN RANGE—C.S.W., 1876, p. 159.
WEE WATTAH RUN—C.S.W., 1880, p. 242.
WELLINGTON :—
C.S.W., 1876, pp. 160-163 ; 1878, p. 152.
E.F.P., 1880, p. 243.
C.S.W. and W.H.J.S., 1890, p. 206.
WELLINGTON CAVES—R.E., 1892, p. 172.
WELLINGTON CREEK—E.F.P., 1880, p. 249.
WELLINGTON VALE—T.W.E.D., 1884, p. 154.
WENTWORTH GOLD-FIELD—C.S.W., 1881, pp. 131, 134.
WERRIS CREEK—G.A.S., 1890, p. 270.
WEST BOGAN MINE—L.H.G.Y., 1880, p. 262.
WESTBROOK CREEK—C.S.W., 1884, p. 151.
WET FLAT—W.A., 1888, p. 181.
WHITBARROW CREEK—W.A., 1887, p. 164.
WHITE CLIFFS—J.B.J., 1892, pp. 140, 141, 142.
WHITE ROCK—C.S.W. and W.H.J.S., 1889, p. 200.
WHITTABREENA RANGES—C.S.W., 1887, p. 137.
WHITLOW CREEK—E.F.P., 1881, p. 142.
WILBERTREE—R.E., 1891, p. 268.
WILCANNIA—C.S.W., 1884, p. 147.
W.A., 1891, pp. 256, 257.
WILGA—W.A., 1887, p. 162.
WILLEROO—C.S.W., 1884, p. 146.
WILLIAMS RIVER—T.W.E.D., 1888, p. 174.
WILSON'S DOWNFALL :—
E.F.P., 1880, p. 245.
H.Y.L.B., 1882, p. 149.
WINGECARRIBEE RIVER—C.S.W., 1890, p. 210.
WISEMAN'S CREEK—C.S.W., 1877, p. 203.
WOLLON HILLS—W.B.C., 1884, p. 158.
WOLLONGONG :—
C.S.W., 1875, p. 119.

WOLLONGONG—*continued.*
T.W.E.D., 1890, pp. 234, 235, 236.
T.W.E.D. and G.A.S., 1890, pp. 249, 254.
J.C.H.M., 1891, p. 278.
WOMBAT—L.H.G.Y., 1878, p. 177.
WOMBEYAN—L.H.G.Y., 1879, p. 227.
WOMBEYAN CAVES—W.S.L., 1888, p. 203; 1889, p. 253; 1892, p. 177.
WONGAWILLA—T.W.E.D., 1890, p. 255.
WOODFORD—T.W.E.D., 1887, pp. 150, 152; 1888, p. 174; 1889, p. 229.
WOODLANDS'—C.S.W., 1890, p. 209.
WOOD'S FLAT:—
C.S.W., 1878, p. 150.
T.W.E.D. and G.A.S., 1890, p. 239.
WOODS REEF—W.A., 1888, p. 182.
WOODSTOWN—C.S.W., 1881, p. 138.
WOODWARD'S GULLY—T.W.E.D., 1889, p. 215.
WOOLOOMIN—C.S.W., 1885, p. 135.
WYAGDON—C.S.W., 1879, p. 214.
WYALONG—C.S.W., 1881, p. 138.
WYANBENE—W.A., 1891, p. 253.
WYBONG CREEK—T.W.E.D., 1889, p. 213.
WYBUNG HEAD—T.W.E.D., 1890, p. 234.
WYEE—T.W.E.D., 1891, p. 245.
WYLIE CREEK—H.Y.L.B., 1882, p. 149.
WYNDHAM SWAMP—T.W.E.D., 1884, p. 153.
WYONG:—
C.S.W., 1884, p. 148.
T.W.E.D., 1888, pp. 166, 167; 1890, p. 219.
WYONG STATION—C.S.W., 1881, p, 132.
YALWAL:—
E.F.P., 1883, p. 159.
T.W.E.D. and G.A.S., 1890, p. 251.
YANCOWINNA—C.S.W., 1884, p. 147.
YANCOWINNA CREEK—C.S.W., 1887, p. 143.
YANDA—T.W.E.D., 1890, p. 243.
YANKEE CREEK—C.S.W. and W.H.J.S., 1889, p. 203.
YARRAMALONG—T.W.E.D., 1890, p. 219.
YARRANGOBILLY:—
W.A., 1886, pp. 163, 164, 165.
J.C.H.M., 1890, p. 287.
R.E., 1891, p. 268.
W.S.L., 1891, pp. 282, 283.

YARRANGOBILLY CREEK—W.A. and W.S.L., 1891, p. 249.
YARRAHIPINNI:—
C.S.W., 1880, p. 240.
L.H.G.Y., 1880, p. 251
YARRAHIPINNI RANGE—C.S.W. and W.H.J.S., 1889, p. 205.
YARROW CREEK—C.S.W., 1883, pp. 154, 155.
YASS:—
C.S.W., 1876, p. 149.
T.W.E.D., 1882, p. 148.
YAVEN CREEK—E.F.P., 1881, p. 140.
YELLOW CREEK—T.W.E.D., 1886, pp. 159, 162.
YELLOW ROCK—C.S.W., 1885, p. 133.
YETHOLE—E.F.P., 1881, p. 139.
YOUNG:—
C.S.W., 1876, pp. 153, 154; 1878, p. 151.
W.A., 1890, p. 266.
YOWAKA—W.A., 1890, p. 263.
YUGILBAH—E.F.P., 1879, p. 226.
Y. WATERHOLES:—
C.S.W., 1883, p. 148.
T.W.E.D., 1883, p. 156.

XXVIII.—On the occurrence of *Lepidodendron australe* (?) in the Devonian Rocks of New South Wales: by T. W. E. DAVID, B.A., Professor of Geology, Sydney University, and E. F. PITTMAN, A.R.S.M., Government Geologist.

[Plates XVII–XIX.]

Historical.

THE earliest recorded discovery of *Lepidodendron* in Australia, as far as we are aware, is that of Sir Thomas Mitchell,* who in 1835 found *Lepidodendron* at Wallamoul, Peel River, near Tamworth, and forwarded the specimen to Mr. W. Lonsdale, F.G.S., who identified and described it in 1853.

In 1848 the Rev. W. B. Clarke, F.R.S., recorded† the occurrence of *Lepidodendron* "from the shales of the Manilla River, and on the Namoi and Gwydir Rivers,

* Recent Geological Discoveries in Australasia. Rev. W. B. Clarke, read before the Philosophical Society of New South Wales, 20th November, 1861.

† On the Genera and Distribution of Plants in the Carboniferous System of New South Wales—*Quart. Journ. Geol. Soc.*, 1848, IV, p. 60. (Quoted by Mr. R. Etheridge, Junr. *Records Geol. Survey N. S. Wales*, II, Pt. 3, p. 120).

from the grits and sandstones of the Paterson River, and from the hard siliceous metamorphic rocks of Colocolo on the Allyn River, associated with Brachiopoda and Trilobites."

The Rev. W. B. Clarke states* that in June, 1851, Professor McCoy wrote to him from Cambridge respecting the first *Lepidodendron* he had seen from Australia, and which had been forwarded by Mr. Clarke in 1849 to Professor Sedgwick. Professor McCoy stated that this specimen was identical with *L. tetragonum* of the English coalfields. In November, 1863, (*loc. cit.*), Sir C. Bunbury, in a letter to Professor R. Jones, confirmed Professor McCoy's opinion considering the Australian fossil to be very like *L. tetragonum.*

In 1853, Mr. S. Stutchbury,† at that time Government Geological Surveyor, records having found at the crossing place of the Oakey Creek, four miles from Cobbadah, several specimens of *Lepidodendron* in argillaceous shales and sandstones. He also figures (*loc. cit.*) in outline, one of the specimens from that locality. It is probable, from the rectangular form of the leaf scars, that the specimen was specifically identical with the one forwarded to Sedgwick.

Subsequent discoveries of *Lepidodendron* in 1855 by Mr. F. Odernheimer, in the Peel River District, and in 1856 by Mr. J. S. Wilson, at Goonoo Creek, near Tamworth, are alluded to by Mr. R. Etheridge, Junr., in his paper previously quoted.‡

In 1861, Professor (now Sir Frederick) McCoy, F.R.S., described and named *Lepidodendron australe* from the rocks of the Avon River, Gippsland, Victoria. These rocks are classed by Mr. R. A. F. Murray, F.G.S., Government Geologist, as Upper Devonian, though he states that they are strongly uncomformable to the Middle Devonian rocks of Victoria, and therefore that§ "it is highly probable, judging from their stratigraphical position, that the Avon sandstones are—as indicated by Professor McCoy, on palæontological evidence—of Lower Carboniferous age, or passage beds in that direction upwards from the Upper Devonian beds."

In 1870 Mr. R. Daintree, F.G.S., who was then Government Geologist of Queensland, found specimens of *Lepidodendron* in that Colony, and those collected by him from Mt. Wyatt, Canoona, and the Broken River, were subsequently identified by Mr. W. Carruthers, F.R.S.,‖ as *Leptophlæum rhombicum*, previously described by Dawson as occurring in the Upper Devonian Series of Canada. In Appendix II, Mr. Carruthers describes†† these Queensland plant fossils as *Lepidodendron nothum*, Unger, from which it appears that the two names were regarded as synonymous.

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* Sedimentary Form. N. S. Wales, Fourth Edition, 1878, p. 21.
† Geological Surveys, New South Wales. Letter to Colonial Secretary, dated 1st July, 1853 (published as a Parliamentary Paper), p 9.
‡ Records Geol. Survey, N.S.Wales, II, Pt. 3.
§ Geology and Physical Geography of Victoria, 1887, p. 67.
‖ Quart. Journ. Geol. Soc., 1872, XXVIII, p. 259.
†† *Loc. cit.* p. 358.

At Mt. Wyatt* the plant-beds are stated to be interstratified with strata containing *Spirifer*, &c.; no figures of these *Spiriferæ* appear however to have been published.

In 1874 Professor McCoy furnished a detailed description and plate of *Lepidodendron australe*.†

In 1875 Mr. C. S. Wilkinson, F.G.S., F.L.S., Government Geologist of New South Wales, published a geological map of the districts of Hartley, Bowenfels, Wallerawang, and Rydal, and recorded the occurrence, *in situ*, of *Lepidodendron* in altered sandstone beds near the last-named locality. The Rev. W. B. Clarke had previously discovered the fossil in these rocks.

In 1876 and 1877 Mr. Clarke found *Lepidodendron, in situ*, in this neighbourhood, and he states: "I was enabled to detect the plant actually *in situ* and which enabled me‡ to ascertain the proper position of its habitat, which is considerably below the level of the Brachiopod sandstone of Mt. Lambie, and on a spur of that range overlooking Solitary Creek. As a guide to future explorers I left a broad-arrow mark on the fence nearest the spot." During a recent visit to the locality we endeavoured to find this broad-arrow mark, but failed to do so. We were informed, however, by Mr. Francis Lord (of Mt. Lambie House), who had been in company with Mr. Clarke when the mark was made, that it was approximately in the position marked "A" on the accompanying sketch map.

In the year 1875 Mr. John Mackenzie, F.G.S., Examiner of Coal-fields, New South Wales, published§ some sections measured partly by himself showing the occurrence of *Lepidodendron* in the Stroud District. In cutting trenches to explore the Coal Measures in the property of the Australian Agricultural Company, he found *Lepidodendron* (*in situ*) in close association with *Productus, Spirifera*, &c.

In 1877 one of the Authors‖ found *Lepidodendron* at Copeland in the Gloucester District, and a number of specimens were afterwards obtained *in situ* by the collector, Mr. Charles Cullen. The geological horizon from which these specimens were obtained is probably Carboniferous.

Dr. Ottokar Feistmantel, late Professor in the Bohemian Polytechnic University, Prague, formerly Palæontologist to the Geological Survey of India, in 1878 and 1879, published an account of five species of Australian *Lepidodendra* in a work¶ on the Palæozoic and Mesozoic Flora of Eastern Australia. His descriptions and

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* *Loc. cit.* p. 289.
† Prod. Pal. Vict., 1874, Dec. I., p. 37.
‡ Sedimentary Form. N.S.Wales, Fourth Edition, 1878, p. 22.
§ Mines and Mineral Statistics of New South Wales, Sydney, 1875.
‖ Report on the Barrington Gold-field, by E. F. Pittman, A.R.S.M. *Ann. Report Dept. Mines N.S. Wales*, 1877, p. 10.
¶ Palæozoische und Mesozoische Flora des östlichen Australiens. *Palæontographica, Suppl. Bd.* III, *Lief.* 3, *Heft* 2, 3, 4 (Cassel, 1878 und 1879).

figures were based upon two collections of Australian fossil plants forwarded to him by the Rev. W. B. Clarke, in 1876 and 1878. These specimens Dr. Feismantel referred to the following species:—

Lepidodendron australe, McCoy, from Avon River, Gippsland, Victoria.

L. nothum, Unger, Mount Wyatt, Canoona, and Broken River, Northern Queensland, Drummond Range, Queensland. In New South Wales, Cowra, Canowindra, Goonoo Goonoo Creek, Back Creek Diggings, and on the Barrington River.

L. (*comp.*) *dichotomum*, Sternberg, Smith's Creek, Stroud, and Rouchel River, in New South Wales.

L. veltheimianum, Sternberg, Rouchel River, "with abundance of Lower Carboniferous marine forms" (*fide* Rev. W. B. Clarke), and at Smith's Creek, Stroud, in New South Wales, Bogantungan (*fide* Rev. J. E. Tenison-Woods, F.G.S.), Drummond Range, Queensland.

L. volkmannianum, Sternberg, Smith's Creek, Stroud, New South Wales.

The Rev. W. B. Clarke states* that:—"Professor De Koninck also found imbedded with the marine fossils of my collection from the Lower Carboniferous of Muree, Glen William, Burragood, and the Karuah various well-known plants, such as *L. Veltheimianum* (Sternb.)," etc.

This collection was probably forwarded to Professor De Koninck in 1875 or 1876.

In 1889, Mr. Robert Kidston, F.G.S., of Stirling, N.B., described† two specimens of *Lepidodendron* collected by Mr. D. A. Porter of Tamworth, as *Lepidodendron volkmannianum*. Both specimens were in the form of casts, and were considered by Mr. Kidston to be much distorted representatives of *Lepidodendron volkmannianum*, the leaf-scars of which have flat boundary lines with a rounded upper margin. *L. volkmannianum* is restricted to the Culm of the Germans and the Calciferous Series of Scotland. Mr. Kidston considered that the horizon from which the specimens of *Lepidodendron* forwarded to him were collected was probably rather Lower Carboniferous than Upper Devonian.

In the year 1891, Mr. Robt. Etheridge, Junr., contributed an exhaustive paper on the subject of *Lepidodendron australe*.‡ After ably reviewing the distinctive characteristics of *L. nothum*, Unger, and *L. australe*, M'Coy, he records his opinion that the specimens described by Mr. Carruthers from Queensland, are not *L. nothum*, but are specifically identical with *L. australe*, McCoy. Mr. Etheridge further expressed the opinion that the species *L. nothum* had not yet been conclusively proved to occur anywhere in Australia, and considered that all

* Sedimentary Form. N.S. Wales, Fourth Edition, 1878, p. 28.
† Records Geol. Survey N.S.Wales, I, Pt. 1, pp. 114-116.
‡ Records Geol. Survey N.S. Wales, II, Pt. 3, pp 119-134.

the localities from which *L. australe* had been obtained up to the date of his paper were probably Carboniferous or Lower Carboniferous, with the exception of Mt. Wyatt, in Queensland, and Mt. Lambie, in New South Wales, which might possibly be Devonian, though no absolute proof, he considered, had been supplied. Commenting upon the Rev. W. B. Clarke's statement* that the proper position of its *L. australe* habitat was considerably below the level of the Brachiopod Sandstone of Mount Lambie,† Mr. Etheridge concludes that Mr. Clarke did not intend this to mean stratigraphically below the Brachiopod Sandstone, but lower in altitude than that rock.

We are nevertheless of opinion that the expression should be interpreted to mean *stratigraphically below*, as the mere fact of one series of rocks being below another in altitude would in this case have no special significance; the real point at issue, as may be inferred from the context, being the stratigraphical sequence of the Lepidodendron beds and the Brachiopod Sandstone. If this interpretation be correct our recent examination of the locality shows that Mr. Clarke was probably mistaken as to the geological horizon whence his specimens were obtained, with reference to the Brachiopod Sandstone, as the strata marked by him as containing *Lepidodendron* are unquestionably higher in a stratigraphical sense than the Brachiopod Sandstones; and this is clearly and correctly shown in the section upon Mr. Wilkinson's geological map of the Hartley, Bowenfels, Wallerawang, and Rydal Districts.

In 1892, Mr. R. J. Jack, F.G.S., Government Geologist of Queensland, and Mr. R. Etheridge, Junr., in their work† on the 'Geology and Palæontology of Queensland and New Guinea,' describe and figure the following species of *Lepidodendron* from the undermentioned localities:—*L. australe*, McCoy; Corner, Sandy, Horse, and Donald's Creeks, Great Star River; road to Harvest Home two miles west of Mount M'Connell, Mount Wyatt, Canoona, Broken River; Medway River, Bogantungan, and Drummond Range (Star Beds); Training Wall Quarries, Rockhampton, with marine mollusca; Murphy's Tunnel, Pioneer Hill, Hodgkinson Gold Field (Gympie Beds).

L. veltheimianum, Sternberg, Drummond Range; and Bogantungan, Drummond Range. (Star Beds.)

In January, 1892, Mr. W. J. Clunies Ross, B. Sc., F.G.S., contributed a paper "On the Occurrence of *Lepidodendron* near Bathurst,"‡ as a result of his geological observations in the field he shows that the marine Devonian beds are extensively developed near the Winburndale Creek, about from ten up to sixteen miles east of Bathurst. Near this locality he discovered a loose fragment of rock containing

* Sedimentary Forms. N. S. Wales, Fourth Edition, 1878, p 22.
† The Geology and Palæontology of Queensland and New Guinea. By R. L. Jack, F.G.S., F.R.G.S., and Robert Etheridge, Junr. Government Printer, Brisbane, 1892.
‡ Proc. Aust. Assoc. Adv. Sci., 1892, IV, pp. 332-337.

an impression of *L. australe*, occurring under such circumstances as led him to infer that it had probably been derived from a horizon stratigraphically below or identical with that of the Brachiopod Sandstone.

In July, 1892, Mr. P. T. Hammond, Assistant to Mr. Geological Surveyor W. Anderson discovered *Lepidodendron australe* in association with marine fossils, in rocks which are probably of Upper Devonian age on a hill over-looking Back Creek, about three miles from Major's Creek Township. A number of other specimens of *L. australe* (some of them *in situ*) were subsequently discovered in this locality by Mr. W. Anderson, and the Authors. The specimens are preserved as casts in ferruginous gritty sandstones, below which occur purple shales succeeded by marine grits and a basal conglomerate of quartz-felsite resting on an irregularly eroded surface of quartz-felsite.

With the object of collecting further evidence as to the relation of the Lepidodendron beds to the Brachiopod Sandstone of Mt. Lambie the Authors recently made two trips to the locality. During the first trip which took place about the middle of March of the present year, no specimens of *Lepidodendron* showing leaf scars could be discovered, but at the point (*j*) on the accompanying sketch map an obscure impression of a plant probably representing a *Lepidodendron* in a *Knorria* condition was found *in situ* in a bed of quartzite considerably below (stratigraphically) the *Spirifera disjuncta* Sandstones. On the same day in the bed of Solitary Creek at a spot marked (*e*) on the accompanying sketch map, several marine fossils not hitherto recorded as occurring in the Devonian rocks of this locality were collected. Amongst these may be mentioned an *Orthoceras*, and two others, which have been identified by Mr. Robt. Etheridge, Junr., as *Leptodomus* and *Pteronites*, the latter occurring in considerable numbers. These marine shells were associated with abundant casts of *Spirifera disjuncta* and *Rhynchonella pleurodon*. The second occasion on which we visited this district was on the 30th March when we were again unsuccessful in obtaining *Lepidodendron* but on the following day (31st March) we discovered about twenty specimens, *in situ*, at the spot marked (*b*) on the accompanying sketch map, and about half a mile in a southerly direction from where the Rev. W. B. Clarke cut a broad-arrow mark on the fence and from where Mr. Wilkinson obtained five specimens of *L. australe*, in 1875. We marked a tree on top of the ridge about seventy-five yards west of where the *Lepidodendron* occurred.

One of the specimens found by us at this spot is figured on the accompanying Pl. XVII, Fig. 2, and is undoubtedly *L. australe*.

On the afternoon of the same day we collected six specimens, *in situ*, at another locality on the road to Mt. Lambie. This spot is marked (*c*) on the accompanying sketch map and is about three quarters of a mile nearer to the Mount than the locality whence Messrs. Clarke and Wilkinson obtained their

Lepidodendra. Two of the specimens found at the spot marked (*c*) are figured in Pl. XVII, Figs. 1 and 3, respectively. The first is regarded by Mr. R. Etheridge, Junr., as probably a decorticated example of *Lepidodendron;* the second is evidently *L. australe.* Although the spot at which this discovery was made is about a mile nearer to Mt. Lambie than the site of the first discovery, and in a direction nearly at right angles to the strike of the beds, it is probable that the specimens from both places were on about the same geological horizon, as a synclinal trough intervenes, occasioning a repetition of the beds. This syncline is partially shown on the section accompanying Mr. Wilkinson's map, but is illustrated in greater detail on the sketch section accompanying this paper.

On the 1st April, we found at the point marked (*d*) on the accompanying sketch map a cylindrical cast of *Lepidodendron* in an angular fragment of rock containing marine fossils. This fragment measured about nine inches by six, and consisted of gritty sandstone with small angular pieces of clay slate. From the appearance of the fragment there is no doubt that it had not travelled many hundred yards, and must have been derived from a horizon several hundred feet stratigraphically below the uppermost stratum of sandstone containing *Spirifera disjuncta.* This specimen although in an imperfect state of preservation, shows traces of leaf scars sufficiently distinct to warrant its being classed as some form of *Lepidodendron*, probably *L. australe.* It has been well reproduced in the accompanying plate by Mr. P. T. Hammond, Pl. XVII, Fig. 4. Two of the casts of marine fossils with which it is associated are also shown in the plate, Pl. XVII, Figs. 5 and 6. Imperfect casts of a number of small shells, probably *Rhynchonella* were also present in the fragment. Inasmuch as no marine fossils are known to occur in this series above the *Spirifera disjuncta* beds, this Brachiopod ranges to the top of the Marine Upper Devonian Series in this locality. The association of marine fossils with this specimen of *Lepidodendron* conclusively proves that its horizon must have been stratigraphically below the top of the marine Upper Devonian, and, therefore, there cannot in our opinion be any doubt as to the occurrence of *Lepidodendron* in Upper Devonian rocks.

The only alternative interpretation of the facts recorded would be that *Spirifera disjuncta* in Australia may possibly extend upwards into Lower Carboniferous rocks. On our return to Sydney we received communications from Mr. Clunies Ross, announcing that he also, on the 31st of March, had discovered a somewhat indistinct cast of *Lepidodendron australe,* associated with *Spirifera disjuncta,* in a large mass of rock practically *in situ.* The site of this discovery was about sixteen miles easterly from Bathurst.

A strong unconformability is observable at the junction line of the Permo-Carboniferous Upper Marine conglomerates in the neighbourhood of Rydal, with the *Spirifera disjuncta* and Lepidodendron beds, as is well shown on the section accompanying Mr. Wilkinson's map.

Interstratified with the whitish quartzites and sandstones of the Marine Devonian, and the clay shales of the Lepidodendron beds, are thick strata of reddish purple shale, analogous to the smaller beds recorded above at Back Creek, near Major's Creek township and similar (as far as can be judged from the description) to the purple shales associated with sheets of melaphyre in the Devonian rocks of the Avon River, Victoria.*

Conclusion:—In our opinion *L. veltheimianum*, *L. volkmannianum*, and *L. dichotomum*, in the present state of our knowledge of the stratigraphy of Eastern Australia, are referable to a Carboniferous or Lower Carboniferous horizon.

If we adopt the decisions of Sir Frederick McCoy, Messrs. R. Etheridge, Junr., and R. Kidston, viz., that the Australian specimens of *Lepidodendron* referred to *L. nothum* Unger, by Mr. Carruthers are identical with *L. australe*, the species *L. nothum* may be eliminated from the list of Australian fossils. The fact, however, must not be overlooked that Mr. R. Kidston considers it possible that some of the specimens of *Lepidodendron* from Australia described by Mr. Carruthers as *L. nothum* may be more nearly related to *Leptophlœum rhombicum*, Dawson, than to *L. australe*, McCoy.

In some parts of Australia *L. australe* is certainly found in rocks of Carboniferous or Lower Carboniferous age, and in view of the recent discoveries by Mr. Clunies Ross and ourselves, there can be no doubt that a *Lepidodendron*, probably *L. australe* occurs in *Spirifera disjuncta* beds near Mount Lambie; and if these beds are not Upper Devonian, it must be admitted that in Australia *Spirifera disjuncta* has a higher range than has been proved for this species in the northern hemisphere.

The discoveries of Mr. P. T. Hammond and Mr. William Anderson are likely to confirm our contention that in some parts of New South Wales *L. australe* is probably of Upper Devonian age.

XXIX.—On Celestine from the Neighbourhood of Bourke: by GEORGE W. CARD, A.R.S.M., Curator and Mineralogist.

IN turning over a number of miscellaneous specimens in the Museum Collections two nodules were found whose weight and general appearance suggested the desirability of a closer examination. This has been done with the result that they prove to be composed of Celestine, the sulphate of strontia. Both pieces were labelled "Bourke." Every effort has been made to trace the history of the

* R. A. F. Murray, Geology and Physical Geography of Victoria, pp. 66-67.

specimens and the exact locality from whence they came; but with indifferent success. They appear to have been received from the Bourke District not more than two years ago.

Together the pieces weighed about twelve ounces. The specific gravity, as determined by two of the Assistants, Messrs. G. Allen and L. F. Harper, by the Joly Balance, is 3·73*, the relatively high density of the stone being very noticeable when held in the hand. Close inspection shows that the mass is made up of a number of small crystals—not exceeding two millimetres in length. So far as they can be made out the crystals appear to be the simple tabular forms characteristic of celestine, but it is difficult to make the faces out distinctly. The more perfect faces have a vitreous lustre, and are sometimes notched or otherwise marked with angular depressions. The streak is quite colourless as is also the mineral itself, except where superficially reddened.

The softness of the mineral as a whole is such as to suggest gypsum, were it not for its high density, it being readily scratched with the thumb-nail. Even the crystal faces do not seem to quite attain the hardness usual to celestine (3–3·5).

Before the blow-pipe the reactions for strontium, and for a sulphate, are readily obtained, the flame-colouration being very pronounced.

The ultimate analysis of the mineral, for which I am indebted to Mr. J. C. H. Mingaye, is as follows:—

Moisture	·70
Sulphate of Strontia ($SrSO_4$)	93·57
Sulphate of Lime ($CaSO_4$)	·99
Sulphate of Baryta ($BaSO_4$)	trace
Silica (SiO_2)	3·22
Oxide of Iron and trace of Alumina	1·52
Magnesia (MgO)	·33
Chloride of Sodium (NaCl)	trace
	100·33

From the general appearance of the substance it seems probable that it occurs as nodules in the gypsum deposits.

As this is the first recorded instance of a strontium mineral from this Colony, a few remarks as to the occurrence and uses of strontium compounds as may be out of place.

Two strontia minerals are known,—the sulphate, celestine, and the carbonate strontianite.

* Pure celestine has a Sp. Gr. of 3·9.

Celestine occurs in considerable quantity in the Triassic marls of Gloucestershire, England. In 1891 the output from this district amounted to 8,061 tons of a value of £4,030 at the mines, while in 1892 these figures were 5,066 and 1,266 respectively. The output appears to be steadily decreasing. This mineral is also associated with the sulphur deposits of Girghenti, Sicily, which are of volcanic origin. As much of the gypsum from the western districts appears to be a deposit from the mud-springs, it may be that the celestine which forms the subject of this note may prove to have an origin analogous to that of the Sicilian mineral.

Strontianite was first described from a district in Argyleshire, Scotland, and occurs in small quantities as a secondary product in limestones and other rocks in many localities. Both minerals may be said to be of rare occurrence.

The application of strontium salts in the arts is a very limited one. Celestine is utilised in the manufacture of the nitrate of strontia, which is the basis of the red fire made use of in pyrotechnic displays. The process is a very simple one, consisting in the reduction of the sulphate to sulphide by heating with charcoal in a crucible, and neutralising the solution of the sulphide in water with nitric acid. Crystals of the nitrate are obtained on evaporation.

It is stated* that the strontianite of Westphalia, which occurs in veins in the Cretaceous strata, is being used for the production of caustic strontia, which is of use in the refining of sugar.

Should it prove possible to obtain celestine economically, there seems to be no reason why it should not be used locally in the manufacture of fireworks.

The weight of celestine renders it possible to readily distinguish it from gypsum, while the crimson colour that it imparts to a flame, when moistened with hydrochloric acid—spirits of salt—is very distinct from the greenish flame obtained from barytes, which is also characterised by its density, when similarly treated.

* Bauerman, Descriptive Mineralogy, 1834, p. 359.

PLATE XVI.

Palorchestes azael, *Owen*.

Fig. 1. Right upper molar series, showing pm^4 and m^{1-3}.

Fig. 2. Specimen of palatal region, with pm^4 and m^{1-3} on each side. x $\frac{1}{2}$.

Fig. 3. Left upper molar series, viewed from without.

Fig. 4. Inner view of left pm^4 showing portion of inner root.

Fig. 5. Portion of left maxillary showing the relative form of the roots of left pm^4.

Drawn from nature by Mr. G. H. Barrow, and with the exception of Fig. 2, all are of the natural size.

1

2

4

5

3

Heliotype.

PLATE XVII.

Lepidodendron australe, *McCoy*.

Fig. 1. Probably the decorticated or *Knorria* condition.

Fig. 2. Impression of part of a stem.

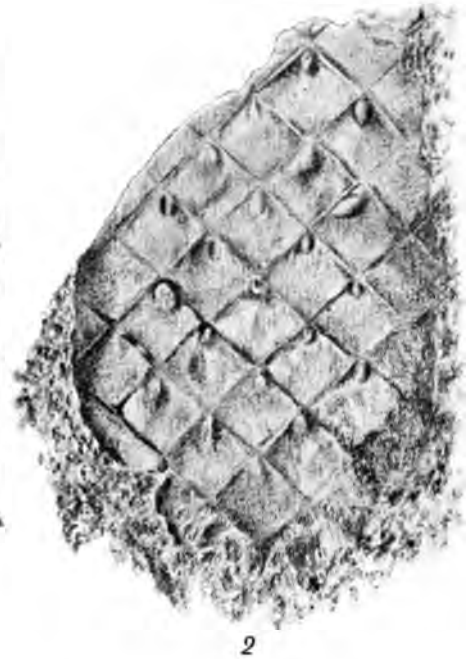
Fig. 3. Impression of part of a stem.

Fig. 4. Impression of the surface in the round.

Fig. 5 & 6. Undetermined shells.

Drawn from nature, of the natural size, by Mr. P. T. Hammond.

1



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P. T. Hammond, del. Heliotype.

PLATE XVIII.

Sketch Map (after the late Mr. C. S. Wilkinson) of the Mount Lambie District.

Scale, 40 chains = 1 inch.

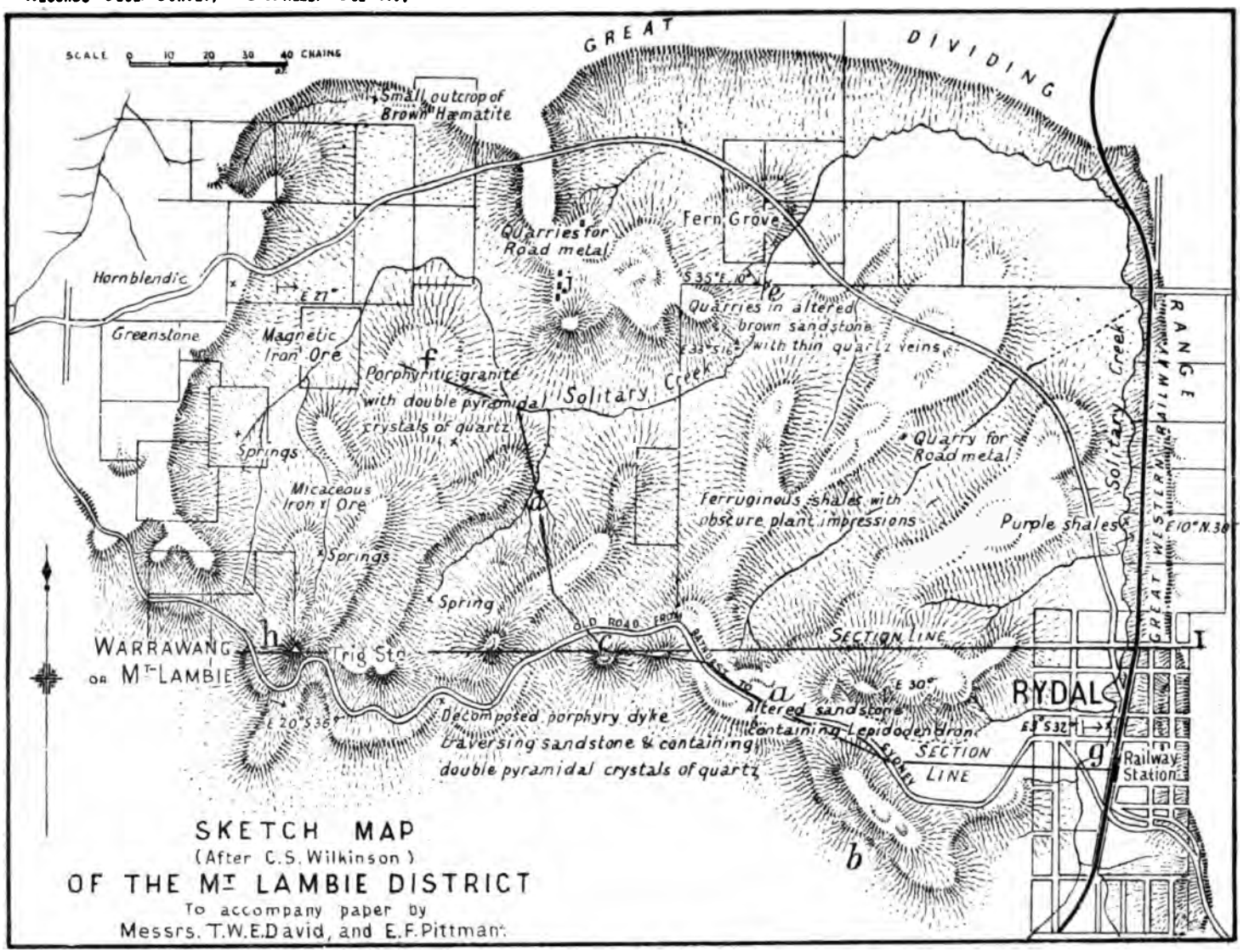

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PLATE XIX.

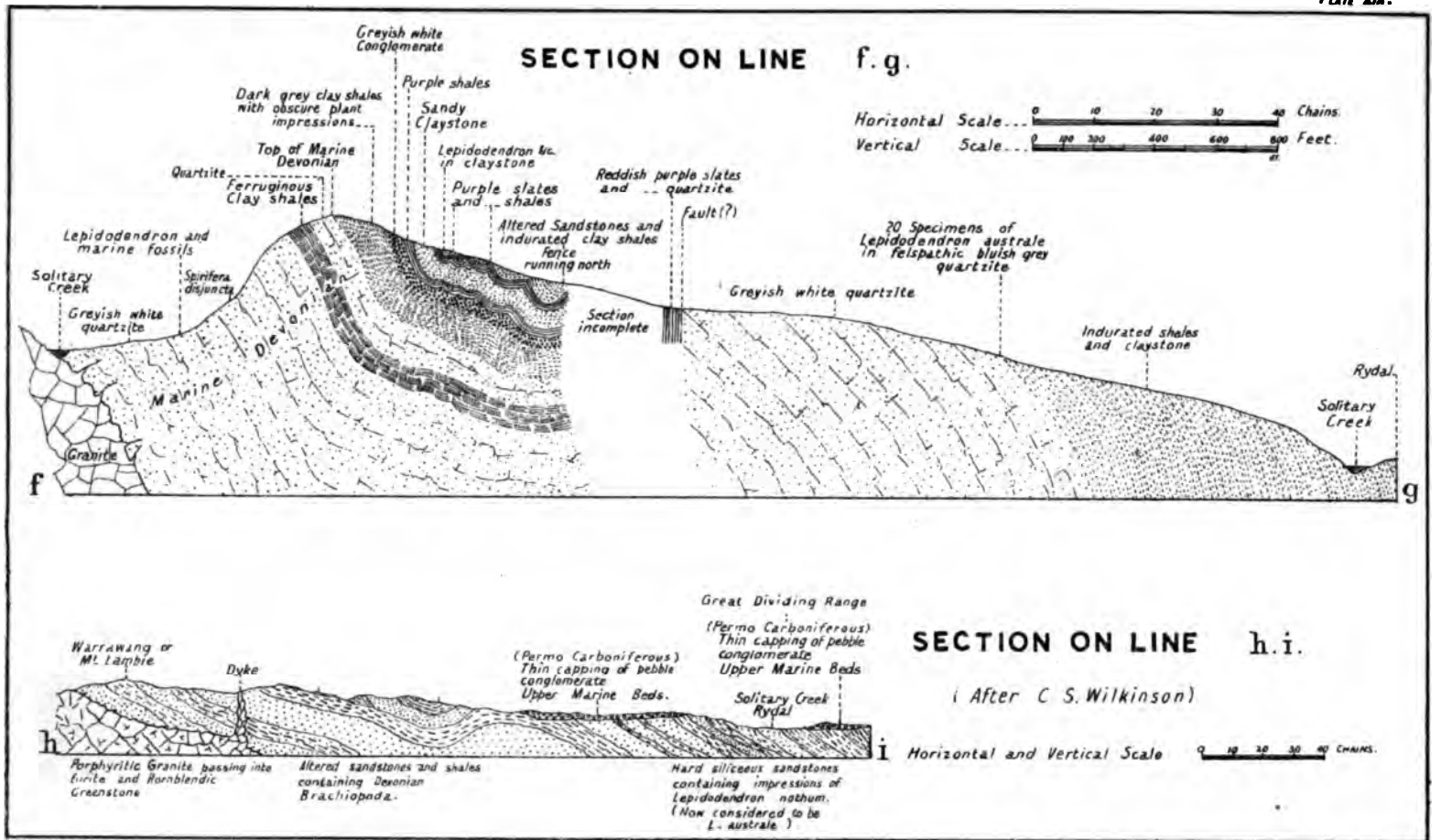
Horizontal Sketch Sections through the Mount Lambie District—to accompany Sketch Map, Plate XVIII.

Section *f*—*g*, by Messrs. David and Pittman.

Section *h*—*i*, after the late Mr. C. S. Wilkinson.

Hor. scale—20 chains = 1 inch.

Vert. scale—400 ft. = 1 inch.



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DEPARTMENT OF MINES AND AGRICULTURE, SYDNEY.

RECORDS

OF THE

GEOLOGICAL SURVEY OF NEW SOUTH WALES.

Vol. IV.] 1894. [Part I.

I.—On the Discovery of Coal under Cremorne, Sydney Harbour:

by T. W. E. David, B.A., F.G.S., Professor of Geology, Sydney University, and E. F. Pittman, A.R.S.M., Government Geologist.

[Plates I and II.]

I.—Introduction.

There is evidence to show that as long ago as 1847, the late Rev. W. B. Clarke believed in the existence of coal underneath Sydney, for in his evidence given in that year before the Select Committee of the Legislative Council on "Coal Inquiry," he said: "If we take a dip of only one degree from Newcastle to the south, and from Illawarra to the north, the synclinal curve will meet at the entrance to Broken Bay, which is exactly half way (the extremity probably of the minor axis) at a depth of 4,680 feet—*the depth of the coal seams if continuous.*"

Of late years the existence of coal under Sydney has been regarded by local geologists as almost a certainty, the only point in connection with it upon which there was any divergence of opinion being the depth at which it was likely to occur. The relation of the coal seams at Newcastle to those at Bulli was reported upon by one of the Authors in 1890*, and two theories as to the probable sequence

Vide Report by T. W. E. David, B.A., F.G.S., Geological Surveyor. *Ann. Rept. Dept. Mines for* 1890 [1891], p. 234-235.

of the Permo-Carboniferous rocks under Sydney were discussed, and it is satisfactory to note that the theory then put forward as the most probable one has been substantially proved to be correct by the discovery of the Bulli seam in the diamond drill bore at Cremorne, lately finished under the supervision of Mr. W. H. J. Slee, the Superintendent of Diamond Drills.

II.—*Details of Bores near Sydney.*

Quite a number of diamond drill bores have, within the last fourteen or fifteen years, been put down in or near Sydney with the object of proving the depth at which coal actually occurs. The following is a list of these bores in the order in which they were completed:—

(1.) *The Newington Bore.*—This was put down under the supervision of Mr. J. Coghlan, at Newington, on the Parramatta River, in 1878. This bore was abandoned at a depth of 1,312 feet without reaching coal. The chocolate shales were penetrated (according to Dr. J. C. Cox) at a depth of 1,100 feet. Scales of native copper were observed in the shales in this bore in 1878 by Mr. J. Waterhouse, M.A., but their horizon is probably considerably higher than that of the cupriferous tuffs proved in some of the later bores.

Previous References.—C. S. Wilkinson, Ann. Rept. Dept. Mines for 1878 [1879], p. 155.
S. L. Bensusan, Journ. R. Soc. N.S. Wales, 1878, XII., p. 254.
T. W. E. David, Proc. Austr. Assoc. Advt. Sci., 1888 [1889], I., p. 275.
T. W. E. David, Trans. Geol. Soc. Austr., 1888, I., Pt. 3, pp. 83-89.
J. C. Cox, Proc. Linn. Soc. N.S. Wales, 1881, V., Pt. 3, p. 274.

(2.) *Holt-Sutherland Bore*, No. 1 (*Botany*).—Mr. J. Coghlan.—This bore was abandoned in 1879 at a depth of 2,193 feet without having reached coal. The chocolate shales were penetrated at a depth of 880 feet.

Previous References.—Ann. Rept. Dept. Mines for 1879 [1880], p. 208.
Mineral Products, 2nd Ed., 1887, pl. 6.

(3.) *The Moore Park Bore.*—Was put down by Mr. J. Coghlan at a spot about half a mile southerly from the southern end of Bourke-street, and was abandoned in the year 1880 at a depth of 1,860 feet without reaching coal. The site was about twenty feet above sea level. The chocolate shales were struck at a depth of 1,043 feet.

Previous References.—C. S. Wilkinson, Ann. Rept. Dept. Mines for 1880 [1881], p. 241.
J. C. Cox, Proc. Linn. Soc. N.S. Wales 1881, V., Pt. 3, pp. 273-280.
R. Etheridge, Junr., Geol. Survey N.S. Wales, Pal. Mem., No. 1., 1888, pp. 1-4.

(4.) *Holt-Sutherland Bore, No. 2 (Botany).*—Mr. J. Coghlan.—On account of a broken boring tool becoming fixed in the bottom, boring operations were relinquished at a depth of 1,875 feet without coal being struck. The Authors are not aware of any previously published references to this bore.

(5.) *The Camp Creek Bore.*—This bore was also put down by Mr. J. Coghlan near the site where the Metropolitan Coal Company subsequently sank their main shaft at Helensburgh, on the Illawarra Railway line. The height of the site above sea level was 336 feet. The chocolate shales are here seen at the surface on the side of the range. The bore was completed in 1884, and was successful in reaching a seam of coal twelve feet thick at a depth of 846 feet.

Previous References.—C. S. Wilkinson, Ann. Rept. Dept. Mines for 1884 [1885], pp. 151–152.
J. Mackenzie, Ann. Rept. Dept. Mines for 1888 [1889], p. 146.

(6.) *The Heathcote Bore.*—This was completed in 1886 under the supervision of Mr. W. H. J. Slee, Superintendent of Diamond Drills. The site of this bore was opposite Mount Westmacott, and near the Waterfall Station, on the Illawarra Railway line. The site was four hundred and sixty-seven and a-half feet above sea level. The total depth bored was 1,586 feet, and two seams of coal were reached, viz., the upper seam four feet eight and a-half inches thick, at a depth of 1,513 feet, and the lower seam six feet one inch thick, at a depth of 1,577 feet 9 inches from the surface. The chocolate shales were struck at a depth of three hundred and seven feet from the surface. At depths of 1,065 feet and 1,072 feet tuffaceous shales containing scales of metallic copper were met with. A total thickness of seven inches of these shales were observed to be cupriferous.

Previous References.—Ann. Rept. Dept. Mines for 1885 [1886], p. 176.
T. W. E. David, Ann. Rept. Dept. Mines for 1887 [1888], p. 154.
T. W. E. David, Proc. Austr. Assoc. Advt. Sci., 1888 [1889], I., pp. 277, 281, 282, 288.
T. W. E. David, Trans. Geol. Soc. Austr., 1888, I., Pt. 3, pp. 82–89.
R. Etheridge, Junr., Geol. Survey N. S. Wales, Pal. Mem., No. 1, 1888, pp. 1, 4.

(7.) *Holt-Sutherland Bore, No. 3 (Dent's Creek).*—This bore was completed in 1887 under the supervision of Mr. W. H. J. Slee, Superintendent of Diamond Drills. The site of the bore was one hundred and thirty-two feet above sea level, and the total depth reached was 2,307 feet from the surface. The chocolate shales were struck at 787 feet, and two seams of coal were reached, the upper seam (four feet two inches thick) at a depth of 2,228 feet, and the lower (five feet three inches thick) at 2,296 feet 6 inches from the surface. At a depth of 1,764½ feet scales of metallic copper were met with in tuffaceous shales, the latter being first struck at a depth of 1,729 feet.

Previous References.—Ann. Rept. Dept. Mines for 1883 [1884], p. 197.
Ann. Rept. Dept. Mines for 1886 [1887], p. 189.
C. S. Wilkinson, Ann. Rept. Dept. Mines for 1887 [1888], p. 139.
T. W. E. David, Ann. Rept. Dept. Mines for 1887 [1888], pp. 153–154.
T. W. E. David, Proc. Austr. Assoc. Advt. Sci., 1888 [1889], I., p. 276.
T. W. E. David, Trans. Geol. Soc. Austr., 1888, I., Pt. 3, pp. 83–89.
R. Etheridge, Junr., Geol. Survey N. S. Wales, Pal. Mem., No. 1, 1888, pp. 1–4.

(8.) *The Narrabeen Bore.*—This was put down by Mr. J. Coghlan, to the west of Narrabeen Lagoon, about seven miles north of Manly Beach. The bore was abandoned at a depth of about 1,985 feet, without having reached coal. The site of this bore was about five feet above sea level. The chocolate shales were struck at a depth of three hundred and seventy-nine feet six inches, and the horizon of the cupriferous tuffs at 1,715 from the surface.

Previous References.—C. S. Wilkinson, Ann. Rept. Dept. Mines for 1885 [1886], p. 130.
C. S. Wilkinson, Ann. Rept. Dept. Mines for 1887 [1888], p. 137.
C. S. Wilkinson, Ann. Rept. Dept. Mines for 1889 [1890], p. 198.
R. Etheridge, Junr., Geol. Survey N. S. Wales, Pal. Mem., No. 1, 1888, pp. 1-4.
T. W. E. David, Ann. Rept. Dept. Mines for 1890 [1891], pp. 233, 235-237.

(9.) *The Rose Bay Bore.*—Mr. J. Coghlan put down this bore on the Cooper Estate, at Rose Bay, Sydney Harbour. Owing to the bore becoming blocked by a broken tool, operations were abandoned in 1888, the coal not having been reached.

The Authors are not aware of any previously published references to this bore.

(10.) *The Liverpool Moorebank Bore.*—Mr. J. Coghlan also started this bore, and carried it down to a depth of 1,485 feet, and it was subsequently finished under the supervision of Mr. W. H. J. Slee, Superintendent of Diamond Drills. The height of the site above sea level was about forty feet, and the total depth of the bore was 2,601 feet 6 inches. Three seams of coal were reached, the upper (one foot five inches thick) at a depth of 2,493 feet 6 inches, the second (one foot four inches thick) at a depth of 2,507 feet 7 inches, and the lowest (six feet six and a half inches thick) at 2,583 feet 4 inches from the surface.

Previous References.—Ann. Rept. Dept. Mines for 1889 [1890], pp. 136, 148.
Ann. Rept. Dept. Mines for 1890 [1891], pp. 138, 149.
T. W. E. David, Proc. Austr. Assoc. Advt. Sci., I., 1888 [1889], p. 288.
R. Etheridge, Junr., Geol. Survey N. S. Wales, Pal. Mem., No. 1., 1888, pp. 1-4.
T. W. E. David, Ann. Rept. Dept. Mines and Agric. for 1891 [1892], pp. 244-245.

(11.) *The First Cremorne Bore.*—This important bore was put down at Robertson's Point, Cremorne, Sydney Harbour, under the supervision of Mr. W. H. J. Slee, Superintendent of Diamond Drills. The site of the bore was fifty-four feet above sea level, and the total depth reached was 3,095 feet from the surface. The chocolate shales were struck at a depth of 943 feet 4 inches, and at a depth of 2,801 feet 9 inches, a seam of coal, which proved to be seven feet three and a half inches thick, was reached. The coal, however, was found to have been charred or partly converted into coke owing to the intrusion of two dolerite dykes. Previous

to reaching the coal seam the bore passed through two masses of dolerite, and a subsequent examination of the land in the vicinity of the bore revealed the course of the two dykes at the surface.

Previous References.—Ann. Rept. Dept. Mines for 1890 [1891], p. 163.
Ann. Rept. Dept. Mines and Agric. for 1891 [1892], p. 152, and diag. 11.

(12.) *The Second Cremorne Bore.*—After the course of the two dolerite dykes referred to above had been carefully determined, the site for the second Cremorne bore was chosen (by one of the Authors), as far away from both of them as the limits of the available land would allow.* This site was distant about forty chains in a direction north forty-six degrees west from the first bore. The height above sea level of the site of the second bore was one hundred and forty-three feet. Boring operations were commenced in July, 1892, under the supervision of Mr. W. H. J. Slee, Superintendent of Diamond Drills; and on the 9th November, 1893, a fine seam of coal, ten feet three inches thick and free from any alteration by contact with dykes, was penetrated. The depth of the bore from the surface to the roof of the coal-seam was 2,917 feet.

The following is a generalised section of the strata passed through in the bore :—

			Thickness. feet.	inches.	Depth. feet.	inches.
Triassic	Hawkesbury Series	Hawkesbury Sandstones	1,020	6	1,020	6
		(*a*) Chocolate shales	163	6	1,184	0
		(*b*) Sandstones, shales, and conglomerates, with *Thinnfeldia*, *Sphenopteris* (new species), *Macrotæniopteris*, *Odontopteris*, *Sagenopteris*, *Schizoneura*, and *Estheria*	1,112	6	2,296	6
		Narrabeen Beds... (*c*) Tuffaceous, dark green, gritty shales,—horizon of the cupriferous tuff of Holt-Sutherland (Dent's Creek) and Heathcote Bores	60	6	2,357	0
		(*d*) Sandstones, shales, and conglomerates, with concretions of clay ironstone from 2,868 to 2,899 feet	560	0	2,917	0
Permo-Carboniferous.	Newcastle Series	Coal seam	10	3	2,927	3
		Clay, shale, and mudstone, with *Vertebraria*	1	9	2,929	0

The following is a descending section of the seam :—

	ft.	in.
Roof—clay shale.		
Coaly clay shale	0	1
Splint coal, somewhat inferior, with minute veins of calcite	0	8
Coal, splint and bituminous, of good quality	2	10
Band, dark brown clay shale, adhering firmly to coal	0	0½
Coal, splint and bituminous, of good quality, the last three inches rather soft and bituminous	6	4½
Coal, soft, bituminous, a trifle clayey	0	3½
	10	3

Floor—Black carbonaceous clay shale, containing impressions of *Vertebraria*.

* *Vide* Ann. Rept. Dept. of Mines and Agric. for 1892 [1893], pp. 109-110.

III.—Composition of the Cremorne Coal.

The following proximate analyses were made by Mr. J. C. H. Mingaye, F.C.S., Analyst and Assayer to the Department of Mines, of samples from different parts of the seam under Cremorne.

No. 1.—Average sample from first eighteen inches below the eight inches of coal with calcite veins.

Hygroscopic moisture	·65	
Volatile hydrocarbons	17·30	
Fixed carbon	71·75	Coke, 82·05 %
Ash	10·30	
	100·00	

Sulphur, ·795 %. Specific gravity, 1·207. Ash, reddish tinge, flocculent. One pound of this coal will convert 12·7 pounds of water into steam.

No. 2.—Average sample from the next eighteen inches.

Hygroscopic moisture	·70	
Volatile hydrocarbons	17·80	
Fixed carbon	71·60	Coke, 81·50 %
Ash	9·90	
	100·00	

Sulphur, ·562 %. Specific gravity, 1·365. Ash, reddish tinge, flocculent. One pound of this coal will convert 13·3 pounds of water into steam.

No. 3.—Average sample from the next fourteen inches.

Hygroscopic moisture	·80	
Volatile hydrocarbons	16·90	
Fixed carbon	71·05	Coke, 82·30 %
Ash	11·25	
	100·00	

Sulphur, ·617 %. Specific gravity, 1·398. Ash, reddish tinge, flocculent. One pound of this coal will convert 12·9 pounds of water into steam.

No. 4.—Average sample from the next fourteen inches.

Hygroscopic moisture	·70	
Volatile hydrocarbons	17·05	
Fixed carbon	71·25	Coke, 82·25 %
Ash	11·00	
	100·00	

Sulphur, ·802 %. Specific gravity, 1·374. Ash, reddish tinge, flocculent. One pound of this coal will convert 12·9 pounds of water into steam.

No. 5.—Average from the next fourteen inches.

Hygroscopic moisture	·65	
Volatile hydrocarbons	17·95	
Fixed carbon	70·15	Coke, 81·40 %
Ash	11·25	
	100·00	

Sulphur, ·878 %. Specific gravity, 1·373. Ash, reddish tinge, flocculent. One pound of this coal will convert 13·1 pounds of water into steam.

No. 6.—Average sample of the lowest fourteen inches of the seam.

Hygroscopic moisture	·45	
Volatile hydrocarbons	18·45	
Fixed carbon	71·75	Coke, 81·10 %
Ash	9·35	
	100·00	

Sulphur, ·686 %. Specific gravity, 1·362. Ash, reddish tinge, flocculent. One pound of this coal will convert 13·2 pounds of water into steam.

The mean of the foregoing six analyses gives the average composition of the entire seam as follows:—

Hygroscopic moisture	·66	
Volatile hydrocarbons	17·57	
Fixed carbon	71·09	Coke, 81·77 %
Ash	10·68	
	100·00	
Mean percentage of sulphur	·724	
Mean specific gravity	1·346	
Mean calorimetric value	13·00	

The aggregate thickness of the coal represented by the above analyses does not equal the total thickness of the coal as given in the section of the seam, because some of the core was reduced to powder and lost during the boring operations.

It is evident from the above that the Cremorne seam consists of good coal especially suitable for steaming purposes, and that it is rather superior to the Illawarra or Southern coal, particularly in regard to the percentage of ash.

The temperature at the bottom of the bore was ascertained by one of the Authors, the apparatus employed being so constructed as to protect the thermometers from the great pressure due to the depth. When the experiments were made the lowest portion of the bore was found to be obstructed by caving, but at a depth of 2,733 feet the temperature was observed to be 97° Fah. If the mean annual temperature of Sydney be taken as 63°, and if the stratum of invariable temperature be assumed to be fifteen feet below the surface, this result will be found to be equal to an average increase of 1° Fah. for every eighty feet of descent, and at this rate the temperature of the earth's crust at the depth of the coal seam would be 99·3° Fah. It may, however, be noted that the experiments in connection with the temperature were made in a bore, the site of which was nearly one hundred and fifty feet above sea level, and as the working shaft of the colliery will probably be sunk at a spot very much closer to high-water mark the actual temperature of the coal seam is likely to be quite 1° less than that deduced from the experiments.

The ascertained temperature is much more favourable than could reasonably have been anticipated, as the average rate of increase of temperature in different parts of the world is 1° for every sixty-three feet in depth, and there is every reason to expect that, with the aid of the most modern ventilating appliances, the temperature of the coal workings under Sydney harbour will be reduced to about 80° Fah.

The positions of the different bores referred to in this paper are shown on Pl. II, and the approximate dips of the chocolate shales, the cupriferous tuffs, and the coal seam are given in two sections (Pl. I), viz., from Camp Creek northerly to Narrabeen, and from Liverpool north-easterly and easterly to Cremorne. The position of Wyong Creek is also shown, immediately to the north of which chocolate shales, similar to those of Narrabeen, outcrop in the railway cuttings.

II.—Columnar Structure in Quartz-Felspar Porphyry at Mount Hope, Co. Blaxland, N. S. Wales: by JOHN B. JAQUET, A.R.S.M., F.G.S., Geological Surveyor, and GEORGE W. CARD, A.R.S.M., F.G.S., Curator and Mineralogist.

ABOUT a mile distant, in a westerly direction from the South Copper-mine, in the vicinity of Mount Hope, a low hill, composed of quartz-felspar porphyry, is to be found intruding (?) clay-slates, which can be observed in some places at its base. The whole of the upper portion of the boss is marked out by joints into a system of hexagonal columnar blocks, and, in some places, owing to unequal denudation having occurred, the columns so exposed stand out above their neighbours. The greatest observed height of these columns above the general surface of the hill was six feet, while the width of the faces varies between one foot and eighteen inches. Some of them, as a result of weathering, have assumed rudely-pointed terminations.

From a description given by Mr. Cawse, General Manager of the Mount Hope Copper-mine, it would seem as if columns exhibiting a "cone-in-cone" structure could be seen at one time, but now every instance of this structure appears to have been effaced. During the period when the copper mines were being exploited on a large scale, and a considerable population was resident at Mount Hope, boys from this town were accustomed to resort to this hill and wedge out the columns with crowbars in order to watch them roll down its sides; the base of the hill is now strewn with the broken remains of columns sacrificed in this manner.

A subsequent examination of the prominent hill which overlooks from the west the township of Mount Hope, and is distant from it about a mile and a half, showed it also to consist of the porphyritic rock, with a system of hexagonal jointing.

The district was traversed in 1875* by the late Mr. Lamont H. Young, A.R.S.M., Geological Surveyor, and, according to the information supplied by him and charted on the Geological Map of the Colony, the porphyry covers a large area of country in the vicinity of Mount Hope.

The time at the disposal of the observer† for the purpose of investigating the relations existing between the sedimentary and igneous rocks was very limited; hence the Authors of this paper do not think they are warranted in speaking definitely as to whether the latter is intrusive or otherwise. However, if the

* Ann. Rept. Dept. Mines N.S. Wales for 1880 [1881], pp. 259–263.
† The rock was examined in the field by only one of the Authors.

detailed description of the rock, which is given hereafter, be referred to, it will be seen that, after consolidation, many of its component minerals have undergone considerable alteration, and these changes are of such a nature as could only have taken place at some depth beneath the earth's surface—they are not those that might reasonably be expected to result from weathering. Thus it would seem that the rock does not represent a much altered lava-flow of, comparatively speaking, recent origin; and, moreover, the fact that it has an acid composition, and is found over a large area, militates against any such hypothesis.

Where hexagonal jointing has been observed in rocks which undoubtedly represent consolidated lava-flows the longer axis of the columns are always arranged in a direction normal to the surface of cooling. Now, in the case under description, the columns are vertical, while the slates found as before mentioned at the bottom of one of the porphyry hills, and all the sedimentary rocks of Palæozoic age observed in the district, dip at a high angle; therefore, if, while denying the intrusive origin of the rocks, we admit, in order to satisfy the requirements which its altered condition demand, that it is an ancient lava-flow from which a vast amount of superincumbent rock has been removed by denudation, then it must have been poured out after the formation and subsequent upheaval of the Palæozoic rocks had been effected. Mr. Lamont H. Young assigned a Devonian age to the slates.*

Examined microscopically, the rock is seen to consist of a greyish base—which gives to it a prevailing grey tint, lighter on weathered surfaces—interbedded in which are many porphyritic crystals of felspar, quartz, and a soft blackish mineral. Quartz is present in the form of numerous glassy blebs. Felspar is very abundant; it is uniformly white in colour, and sometimes shows good cleavage-faces with a vitreous lustre; some of the crystals are of very considerable size. A very close connection is sometimes evident between the felspar and the soft blackish mineral referred to above. This latter occasionally forms complete pseudomorphs with approximately rectangular outlines. The rock is occasionally traversed by thin veins of calcite. The mean of several determinations made by the Curator's Assistant, Mr. L. F. Harper, gave a specific gravity of 2·65.

Two thin-sections have been prepared from the specimens available. A microscopic examination shows the base to be completely micro-crystalline, and to consist very largely of what is perhaps quartz. Microlites of what appears to be white mica occur occasionally. A sort of micropegmatitic structure is sometimes noticeable (Slide 428†), in which an angular fragment of quartz often constitutes a nucleus to a circular area which, to a large extent, extinguishes simultaneously with it. These areas may, perhaps, be analogous to spherulites.

* *Loc. cit.* p. 260.

† The numbers are those under which the microscope-slides are registered in the Collections of the Geological Survey of N.S. Wales.

Quartz.—This occurs as large, very much broken, often idiomorphic crystals, and as small angular fragments scattered through the base. The larger masses contain numerous glass-inclusions—some with fixed bubbles—and are also traversed by cracks along which numerous minute cavities are arranged. Slide 431 shows an inclusion of a mineral with pleochroism in green and white. There is no trace of undulatory extinction. The corrosion by the magma has been so very intense as to remind one of the similar phenomenon common in many rhyolites.

Felspar.—This mineral frequently occurs as idiomorphic crystals in which the characteristic faces of orthoclase are sometimes well-marked. Both simple and compound twinning may be noticed, but kaolinisation has usually advanced so far as to obliterate all such structures. A considerable development of epidote has gone on at the expense of the felspar. Greenish alteration products, in some cases apparently of a chloritic nature, are common. In one case a passage into what appears to be a white mica occurs.

In each section there is an instance of a fragment of felspar showing secondary growth. In one case (Slide 429), as shown in the figure, a rounded grain has added to its substance on all sides. Both newer and older portions are much kaolinised, the latter rather more than the former as might be expected. A narrow comparatively unaltered zone surrounds the kernel. Twin-lamellation is present; sometimes traversing the whole crystal from end to end, at others occurring only in the newer or the older portion and stopping abruptly on reaching the line of demarcation between them. A development of epidote has taken place in both portions.

Crystal of felspar in which two periods of growth are indicated. Certain of the twin-planes are seen to terminate on the line of division between the two portions. Patches of clear epidote are developed in places, and there is much cloudiness resulting from decomposition. Drawn from Slide 420, as seen between crossed nicols by an inch objective.

It would appear from this that, at an early stage in the history of the rock, it was subjected to conditions which were favourable to the separation of felspar. The kernel, rounded by prior corrosion, resumed its growth and added considerably to its bulk. Subsequently conditions of strain resulted in the development of twin-lamellation which affected both parts of the crystal indifferently; slight breaks in continuity (probably of a physical nature) at the boundary between the two portions sometimes determining the linear extension of the lamellæ. The whole crystal partakes of the alteration resulting from the action of the chemical agencies that have given rise to the development of kaolin and epidote.

In another instance (Slide 428) a crystal of felspar appears to have added to its bulk along two of the edges. As before, a development of kaolin and epidote occurs in poth portions, but the twinning phenomena are absent.

Green alteration products.—These are abundantly developed, and appear to be of a chloritic nature. They occur as minutely fibrous aggregates with a more or less radial structure scattered through the rock, or as compact pseudomorphs sometimes intimately associated with epidote and felspar. They are, if at all, very feebly pleochroic, and generally polarise in mottled neutral tints.* Occasionally patches of a pale brown pleochroic mineral (mica?) occur, and there is also a passage into what may be white mica. Closely associated with these green products is, here and there, a pale brown structureless mineral with a high refractive index, somewhat resembling sphene. It gives very vivid polarisation tints, and generally has an opaque yellowish product developed on it. This substance is also associated with epidote.

III.—Description of a Proposed New Genus of Rugose Coral (*Mucophyllum*) : by R. ETHERIDGE, Junr., Palæontologist and Librarian.

[Plates III and IV.]

I.—Introduction.

AMONGST the corals of Silurian age recorded in lists of New South Wales fossils is *Ptychophyllum patellatum*, Schl., and this reference has been confirmed by the late Prof. De Koninck, who described† a specimen from Dangelong.

* The sections are very thin.
† Foss. Pal. Nouv.-Galles du Sud, Pt. 1, 1876, p. 11.

Ptychophyllum patellatum has never come under my notice, but a coral resembling it in general appearance, although differing considerably in minute points of structure, is met with in moderate quantity at several localities; this it is proposed to describe as *Mucophyllum crateroides.*

I have derived much assistance in unravelling the structure of this coral by reading a paper by Mr. W. H. Sherzer—"A Revision and Monograph of the Genus *Chonophyllum*"*—in which the relations of the last named, *Omphyma* and *Ptychophyllum*, and their delimitation, is fully discussed. His remarks are freely quoted. The difficulties attendant on a study of this group to one situated as the Writer is, far from typical specimens for comparison, and the more important works of reference, have not been lessened by the comparatively recent proposal on the part of Mr. G. Lindström† to merge *Ptychophyllum* in *Streptelasma.*

I purpose giving first a description of the Australian coral, and then comparing its structure with its nearest allies *Omphyma* and *Ptychophyllum*, Sherzer's researches rendering it necessary to say but little about *Chonophyllum.*

II.—Structure of MUCOPHYLLUM—*Gen. nov.*

In outward appearance *Mucophyllum* resembles *Ptychophyllum*, both possessing the same short mushroom-shaped sub-pedicillate corallum. The latter is briefly turbinate below with a short truncated base gradually expanding upwards and outwards, with gently curving concave sides, to a more or less circular periphery (Pl. III, Fig. 1). The upper surface is reflected to form either a horizontal or slightly outwardly curving expansion, giving to the whole corallum the appearance of a low-arched umbrella or mushroom, excavated in the centre, and gradually thinning off to the edge. This edge may be quite sharp and fine, or at times is substantially thick.

In one example the corallum immediately before approaching the edge is a quarter of an inch in thickness.

The size is variable, but specimens have been observed nearly five inches in diameter. The exterior of the corallum below the periphery is enveloped in a thin epithecal covering, and anchoring tubular roots are given off at intervals.

The thin epithecal covering hardly seems to amount to a true epitheca, and presents fine closely abutting concentric lines, which ride over but do not obliterate the costæ. Here and there one of these concentric lines is stronger and almost assumes the appearance of a lamina. At times, immediately around the circular periphery, they become festoon-shaped, and correspond to the imbricate corallum edge. The radii on the under-surface agree in position with the septa, and

* Bull. Geol. Soc. America, 1892, III, p. 253.
† Richthofen's Beiträge Pal. China, 1883, IV Abhandl., p. 65.

correspond to the re-entering angles of the festooned edge, and are therefore "costæ" as distinguished from "rugæ," when occupying a position on the exterior surface of the corallum equal to the interseptal spaces.

The tubular roots, or radiciform processes, are prolongations of the body structure proper and not merely epithecal outgrowths (Pl. IV, Figs. 1, 5). They are hollow, of variable length, but one has been observed as much as one and a half inches long. As a rule, however, they become broken short off, and leave brief wart-like bases to represent the point of outgrowth. Their walls (Pl. IV, Fig. 5) present the same semi-opaque laminated appearance as the body structure of the corallum. This is shown in Pl. IV, Fig. 5 as a very delicate wavy lamination extending from the body substance of the coral into the process. We further learn, from this section, that some at least of these radiciform outgrowths were traversed by diaphragms, two of which are visible, one high up at its junction with the coral proper, and the other near the apex of the process. The latter is one that has clearly not yet attained full development, being rounded and blunt at its termination. The thickest of the objects apparently issuing from the coral is not an anchoring process, but the section of a Crinoid stem. The long tube at right angles to the latter, on the upper left hand of the figure, lying free, illustrates the length to which these processes sometimes attain.

Mucophyllum possesses a wide open centre to the calice (Pl. III, Fig. 2, Pl. IV Figs. 2 and 3), insensibly expanding into the horizontal disc-like portion without the intervention of any thickened rim or line of demarcation. The wall of the calice slopes gently inwards (Pl. IV, Fig. 3), and the floor is practically flat (Pl. III, Fig. 2), and formed by the uppermost tabulum. In the figured specimen, one of our best, this measures one inch in longest diameter, whilst the width of the entire corallum surface, in this instance, is three inches. As I have before said, the "disk" is horizontal and flat, such, for instance, as in Pl. III, Fig. 2; or occasionally it may be gently convex, or the convexity may be restricted to that portion immediately surrounding the calice centre. The turbinate base beneath the calice floor varies greatly in height, being sufficiently deep in some to accomodate several tabulæ (Pl. IV, Fig. 3), or so restricted as to be represented only by the uppermost tabulum, or at the most two tabulæ, which in the former case practically constitutes the truncated base, and reduces the corallum of *Mucophyllum* to an infundibuliform expansion of stereoplasmic matter.

The septa (Pl. III, Fig. 2, Pl. IV, Figs. 2 and 4) are from seventy-five to eighty in a full grown specimen (*i.e.*, in the only species known), of one order, equidistant and simple, radiating outwards from the bottom of the calice to the circular scalloped periphery, where they correspond to the re-entering angles. These septa manifest themselves on the "disc," not as upstanding lamellæ, but as impressed grooves, and do not impinge on the surface of the central tabulate area

but stop short at its margin; there is, therefore, no twisting or formation of a spurious columella (Pl. III, Fig. 2). In only one instance out of a large number of specimens has any deviation from this been noticed, and in this case a very few septa were seen to pass for a short distance inwards and then disappear in the substance of the floor. In thin sections (Pl. IV, Fig. 4), they are seen to be exceedingly delicate and minutely fluctuating lines, and only in a single instance has any trace of secondary thickening been observed, and then to a very slight extent. In this particular case they are split along the centre as if separating into two laminæ. In one septum that has remained entire, a very faint dark line is traceable in the centre—the primordial septum—and it appears to be along this that fracture has taken place. On the other hand, other similarly thickened septa in the same thin section do not show this line.

A short but well marked slightly pyriform fossula exists, containing a single septum, possibly the cardinal, and rather longer than the others. The septa must be regarded as primordial, for not the slightest trace of a secondary thickening has been noticed in any of them, with the exception mentioned above.

Simple transverse dissepiments have been observed in the lower portion of the corallum only (Pl. III, Fig. 1), around the base, but in no single instance have they been seen extending outwards and upwards. They are simple transverse bars dividing the interseptal loculi hereabouts into rectangular spaces.

On the exterior of the corallum the interseptal spaces are somewhat angular around the corallum periphery, but become flatter, and ultimately concave, as the edge of the disk is receded from (Pl. IV, Fig. 3).

The tabulæ are never numerous, usually straight and generally delicate, and with the exception of the uppermost one forming the floor of the calice are either complete or incomplete. There are only three and six respectively in our most tabulate specimens. In the best vertical section I have succeeded in obtaining, the tabulæ are thickened, becoming of the same solid homogeneous nature as the substance of the corallum, and not apparently thickened by a deposition of secondary matter, in fact they seem to be one with the former, although there is no subdivision of this stereoplasmic mass into layers corresponding with the tabulæ, as if the latter represented successive polyp-cups after Edward and Haime's conception of *Ptychophyllum*.

There seem to be hardly recognisable traces of a proper wall, all that is seen in sections is a very delicate thin peripheral line. This can scarcely be looked upon as a theca, for it does not seem to be the result of the commingling of the proximal ends of the septa. It also follows the outline of the radiciform projections.

The tissue forming the entire corallum is composed for the most part of a homogeneous semi-opaque calcite. It fills the whole of the interseptal spaces or loculi, and does not appear to be broken up into a vesicular structure until quite at

the base of the corallum. In vertical sections taken at right angles to the course of the septa, the latter can be traced in their primordial condition without any trace of a secondary thickening, and a similar state of things is exhibited by thin sections parallel to the plane of the disk. The only formation visible is a secondary dendritic crystallisation of a slightly darker colour than the general mass of the tissue. This crystallisation follows the line of each septum, and in a vertical section parallel to the septa appears as a delicate arborescent branching, not unlike the dendritic manganese of landscape marble. In the sections formerly referred to, taken at right angles to the septa, it is not so apparent; but in those taken in the plane of the disk, or horizontal to the growth of the corallum (Pl. IV, Fig. 4), the interseptal spaces are filled with innumerable dots or specks of a dark colour, and small tufts, probably the cut edges of the arborescent branching. Until this feature is thoroughly grasped, this crystallisation leads to the idea that one is dealing with veritable structure.

III.—Cognate Genera.

1. CHONOPHYLLUM.—Edwards and Haime (Brit. Foss. Corals, Pt. 1, Introd., 1850, p. lxix). The characteristic form of this genus is conical, turbinate, or patellate, varying to cono-cylindrical. The successive peripheries, or outer calicular margins, become horizontally expanded, and often reflexed, but there are no radiciform or root-like processes.* There is no true wall, but a simple protective epithecal covering. The calice is either shallow and basin-like, or deep, and the floor is flat. The primary septa near the centre of the calice are thin and lamellar, but gradually thicken towards the periphery of each polyp-cup, and form convex broad bands of complex structure, each septum consisting of a series of upwardly convex superimposed delicate layers, with granular or spinulose processes developed on the upper surface, to aid in the support of each septum. It was the peculiar but misunderstood structure of these lamellar septa that originally gave rise, says Mr. Sherzer, to the description of complete tabulæ, and superimposed and invaginated separate cell-cups. There is no true columella, but the principal septa extending to the calice centre, become more or less twisted. Neither are there any true tabulæ, nor yet a fossula, but the centre of the corallum below the calice is occupied by irregular transverse "leaflets" representing the tabulæ. Dissepiments were developed in the outer narrow interseptal loculi, becoming fewer and more open towards the calice. In *Chonophyllum*, the position of the interseptal loculi is outwardly marked by the narrow longitudinal grooves on the thin epithecal covering.

2. OMPHYMA.—Rafinesque and Clifford (Ann. Sci. Phys. Bruxelles, 1820, V., p. 235). In this genus the form of the corallum resembles the last, with a similar protective epitheca, and no true wall, deposited in "fine encircling bands or

* Sherzer, Bull. Geol. Soc. America, 1892, III, p. 258.

ridges," the strong radiciform processes being direct continuations of the body substance, as in *Mucophyllum*. In *Omphyma* the corallum is made up of superimposed "cell-cups," represented in the infra-calicinal portion by horizontal tabulæ. The septa, unlike those of *Chonophyllum*, are formed by infoldings of the cell-cups, or extended tabulæ, and forming sharply crested, or angular lamellæ, without subsidiary supporting growths, which terminate at the calice margins, and rarely impinge on the central tabulate area. In consequence of this, there is not even a spurious columella. Four fossulæ are usually present, but one is often more distinct than the others. Sherzer states that the septa and interseptal loculi are not clearly differentiated from one another as in *Chonophyllum*, and the Rugosa in general, but the position of the latter is externally defined by broad longitudinal bands.

Omphyma may, therefore, according to Sherzer, be distinguished from *Chonophyllum*, by the following points:—1. Presence of strong radiciform processes. 2. Presence of broad, well-developed tabulæ. 3. Infolding of the cell-cups to form sharply crested or angular septa. 4. Absence of supporting processes. 5. Coarse, subvesicular structure of the interseptal cavities. 6. Generally broad, smooth, central tabulate area. 7. Presence of one or more fossulæ. 8. The broad costal bands representing the interseptal cavities.

3. PTYCHOPHYLLUM.—Edwards and Haime (Mon. Brit. Foss. Corals, Pt. 1, Introd., 1850, p. lxix). From the writings of those who have studied *Ptychophyllum*, Messrs. Edwards and Haime, Roemer, Dybowski, Sherzer, and others, it appears that the corallum is generally similar in appearance to the two preceding genera, and, like *Omphyma*, possesses anchoring protuberances, whilst the margins of the cell-cups are strongly reflected. The formation of the latter, and the radial infoldings of the septa are similar to the structure of *Omphyma*, but as in *Chonophyllum*, the septa extend to the centre of the tabulate area and are there twisted, forming a false columella, and an elevation on the floor, but the septa are not supplied with spicular, or other supplementary appendages. The epithecal covering is strong and persistent, and the broad bands externally developed correspond to the interseptal loculi. The central area is usually strongly tabulate, and the dissepimental vesicles are coarse, as in *Omphyma*. There is a single fossula, and the position of the septa externally is indicated by the fine longitudinal grooves visible on the epitheca. Edwards and Haime believed that the twisting of the septa distinguished this genus from *Chonophyllum*, but Sherzer has shown* that an equal amount of intermingling takes place in the latter.

According to the last-named authority, *Ptychophyllum* is distinguished in detail from *Chonophyllum* by the following characters:— 1. The more persistent epitheca, and occasional radiciform processes. 2. Well-developed tabulæ throughout the central area. 3. Cell-cups forming sharp or angular septa by their radial infoldings.

* Bull. Soc. Geol. Soc. America, 1892, III, p. 279.

4. Absence of supporting growths. 5. False columella. 6. Coarse subvesicular structure of the interseptal loculi. 7. Generally distinct fossula. 8. Longitudinal bands upon the epitheca, corresponding to the interseptal loculi.

Ptychophyllum may be essentially distinguished from *Omphyma*:—1. By the formation of a false columella. 2. Absence of a clear central tabulate area. 3. One fossula, instead of generally four. It, therefore, follows that *Ptychophyllum* is more nearly related to *Omphyma* than it is to *Chonophyllum*.

IV.—The Relations of MUCOPHYLLUM.

We may now enter on the relations of *Mucophyllum* to the three genera just discussed. It resembles all three in the invaginated reflex-margined corallum, which represents one of their "cell-cups;" but so far as my researches have extended there is no repetition of these "cell-cups," nor are there any external accretion ridges as in *Omphyma*. The structure appears to be absolutely homogeneous, and the body of the corallum does not seem to be made up of successive tabular out-growths. The septa are wholly linear-lamellar, without either the complex structure of *Chonophyllum*, or the outwardly angular form of *Ptychophyllum* and *Omphyma*, and I have quite failed to detect any radial infoldings. There is no vesicular tissue in the outer portions of the interseptal loculi, but the whole is filled with a dense structural homogenity. On the contrary, the only dissipiments visible are around the turbinate base in *Mucophyllum*. A thin epithecal covering is present, as in *Omphyma* and *Ptychophyllum*, and the broad external longitudinal bands represent the interseptal loculi, and are therefore practically analogous to the costæ of other Rugose corals. Anchoring processes are unquestionably present, as in both *Ptychophyllum* and *Omphyma;* and, similar to the former, and probably also the latter, these are out-growths of the body substance, and not merely thecal or epithecal developments.

The septa stop short at the central tabulate area, and there is no trace of a spurious columella. Herein, therefore, our proposed new genus is likened to *Omphyma*, and differs from the other two. The tabulæ in the central infracalicular area are well developed, although at times incomplete, again a departure from *Chonophyllum*, and I have quite failed to detect any prolongation of them between the septa to assist in forming an interseptal vesicular structure. One fossula only is present, thus allying our coral to *Ptychophyllum*, and separating it from both *Chonophyllum*, in which there is said by Sherzer to be none, and from *Omphyma* with its four fossulæ as a general rule. The presence of the cardinal septum in the fossula is a decided feature of the Zaphrentidæ.

In conclusion *Mucophyllum* may be said to be, in general terms, an *Omphyma* of one cell-cup possessing linear septa and a single fossula; or a *Ptychophyllum* of one cell-cup, without a spurious columella, and with no projection on the central tabulate area.

V.—Generic and Specific Characters.

MUCOPHYLLUM*—*Gen. nov.*

Gen. Char. — Corallum simple, of one cell-cup, large, patelloid, somewhat turbinate below, with root-like radiciform processes, which are prolongations of the body substance, and not developed from an epitheca or theca. Calice basin-like, with strongly reflected margins, no proper wall visible, but a thin epithecal covering; costæ present. Septa simple, numerous, not formed by lamellar infoldings. Interseptal loculi free, simple, dissepiments only in the lower portions, around the truncate base. Spurious columella absent. Fossula single, large, containing one or more cardinal septa. Tabulæ complete or incomplete, well developed, and sometimes thickened; intertabular loculi narrow, subvesicular at times.

MUCOPHYLLUM CRATEROIDES—*Sp. nov.*

Pls. III. and IV.

Sp. Char.—General characters as in the genus. Corallum attached, attaining as much as four and a half inches in diameter, and one and a quarter inches in height, edge of the calicular disk scalloped; radiciform processes irregularly scattered, attaining one and a quarter inches in length. Calice moderately deep, sides gradually curving outwards, the distal portions forming a more or less horizontal expansion. Septa from seventy-five to eighty, thin, delicate, fluctuating, very rarely thickened, and then only slightly so; fossula short, containing one septum, the cardinal. Central tabulate area wide.

Obs. Mucophyllum crateroides in a very characteristic fossil at certain horizons in rocks at present assumed to be Upper Silurian. I believe it to be the *Ptychophyllum patellatum* mentioned by the late Professor de Koninck, an assumption grounded on the fact that his description of the supposed Australian fossil is nothing more than a slightly free rendering in French of Edwards and Haime's diagnosis† of the British form of that species. At any rate, a *Ptychophyllum* pure and simple, has not yet come under my observation from any Australian locality.

Loc. and Horizon.—Hatton's Corner, Yass River, near Yass (*T. W. E. David, &c.*); Hume or Bowning Series. Old Lime-kiln Ridge, Humewood, near Yass (*W. S. Leigh and R. Etheridge, Junr.*); Hume or Bowning Series. Quedong, Delegate River, Co. Wellesley (*C. Cullen*)—Upper Silurian.

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* ὁ μύκης, a mushroom.

† Mon. Brit. Foss. Corals, 1854, Pt. 5, p. 291.

IV.—Mineralogical and Petrological Notes, No. 2: by GEORGE W. CARD, A.R.S.M., F.G.S., Curator and Mineralogist.

I.—Contents.

1. Eisenkiesel from Fairfield, Drake.
2. Covellite from Broken Hill.
3. Epidote-rock containing metallic copper from Emmaville.
4. Mimetite from Broken Hill.
5. Turquoise from Wagonga.
6. Mispickel in volcanic tuff from Windeyer and Tambaroora.
7. Diamond from Euriowie.
8. Copper-Uranite (Torbernite) from Carcoar.

II.—Mineralogical Notes.

1. ***Eisenkiesel from Fairfield, Drake, New England.***—Deep-red in colour, and spotted with numerous opaque-white globular patches. These patches vary in diameter up to a millimetre; they are somewhat aggregated together and sometimes single, and a cavity often occurs in the centre. Sometimes the white material merely constitutes a rim to a nucleus of brown. In addition to these spots there are a number of irregular cracks and cavities lined with colourless crystalline quartz. The stone takes a good polish, presenting a handsome appearance closely resembling jasper.

Under the microscope [Slide 440] it is found to consist entirely of crystalline quartz; the individuals being of considerable size, and intergrown with one another. Scattered through the mass is a red dust to which the colour of the rock is due. The outlines of earlier crystals, marked by lines of impurities, may sometimes be detected. The silica surrounding such crystals polarises in an irregular manner, suggesting that it may once have existed in chalcedonic form. The white markings are found to consist of aggregations of particles of quartz, which give rise to very irregular polarisation effects.

By reflected light a pattern, traced by opaque-white bands in a manner comparable to the "fortification" structure noticeable in certain agates, is brought out. The outlines of earlier crystals, just referred to, work into these patterns. Within the area marked off by the pattern a number of rings, also bounded by white bands, are sometimes present.

Under favourable conditions of working it is possible that something might be done with this rock should it be found to exist in any quantity.

2. *Covellite from Broken Hill.*—From the Consols Mine, per Mr. G. Smith. Earthy in texture, and of an indigo-blue colour. Intimately associated with massive and crystalline cerussite. It is traversed by veins of cerussite to such an extent as to render it almost impossible to get a pure specimen of the copper mineral. The latter gives off sulphur readily on heating, and is very fusible. Copper reactions are readily obtained.

3. *Epidote-rock containing metallic copper from Emmaville.*—A very hard compact rock, of the usual yellowish-green colour, with small specks of native copper scattered through it. Examined with the microscope (Slide 441) it is found to consist principally of colourless and pale yellowish-green epidote, the spaces between the crystals being filled with quartz, which is sometimes traversed by bundles of colourless acicular crystals radiating from the edges of the epidote. Broken and cleavage-fragments of epidote are included in the quartz. A number of crystals of a purplish colour, and probably augite, also occur. An assay (1372/93) gave traces of gold and silver.

4. *Mimetite from Broken Hill.*—An old specimen labelled "Central Mine." The mimetite occurs with chloro-bromide of silver on ironstone and ferruginous kaolin. The crystals have the usual prismatic habit, and sometimes attain a length of three millimetres. Colour, brown.

5. *Turquoise from Wagonga*—Presented by Mr. C. L. Garland. Pale-blue in colour, occurring in veins of about 3·5 millimetres in width. This is believed to be the first recorded occurrence in New South Wales.

6. *Mispickel in Volcanic Tuff from Windeyer and Tambaroora.*—Collected by Mr. T. W. Atherton. At the Jubilee Mine, Windeyer, the mispickel occurs in nodules presenting a plumose structure when broken across. By comparing a number of specimens the nodules are found to be in reality large crystals built up of curved fibres. In a similar rock from Tambaroora, the mineral occurs in large plate-like crystals.

7. *Diamond from Euriowie.*—Presented by Mr. Paulson, and believed to come from Euriowie. Length, five millimetres. The crystal consists of the hexakis-tetrahedron. It is straw coloured, and somewhat chipped and flawed. Specific gravity, 3·64.

8. *Copper-Uranite (Torbernite) from Carcoar.*—Collected by Mr. T. W. Atherton from the Carcoar Cobalt Mines. It is found adhering to an igneous rock in the form of groups of square plates. These plates are very uniform in size, averaging about a millimetre in length of side. In colour it is emerald-green,

in lustre pearly, and very micaceous in appearance. The quantity available was very small, so that a satisfactory examination could not be made. The following results have been obtained:—

A yellow precipitate on adding ammonic-molybdate to the nitric acid solution.

An occasional copper-green colouration to the blow-pipe flame.

A green microcosmic-salt bead in O.F. and R.F., the colour being perhaps somewhat darker in O.F.

Water doubtful.

A small flake, examined between crossed nicols, gave straight extinctions. No satisfactory interference-figure could be obtained. The occurrence of this mineral in New South Wales has not been previously recorded.

V.—Willyamite—a New Mineral from Broken Hill: by E. F. PITTMAN, A.R.S.M., Government Geologist.

TOWARDS the latter end of last year Mr. George Smith, at that time Assistant Manager, now General Manager of the Australian Broken Hill Consols Mine, discovered what he judged to be a new mineral, associated with dyscrasite in a gangue of calcite and siderite, at a depth of one hundred and fifty feet (vertical) in that mine. He forwarded a specimen of it to me, and stated that he had found it to contain antimony, sulphur, and cobalt. At my request complete duplicate analyses were made of the mineral by Mr. J. C. H. Mingaye, F.C.S., Analyst and Assayer to the Department, who found its composition to be as follows:—

	No. 1.	No. 2.
Sb	56·85	56·71
Co	13·92	13·84
Ni	13·38	13·44
Fe	trace.	trace.
Cu	minute trace.	minute trace.
Pb	minute trace.	minute trace.
S	15·64	15·92
	99·79	99·91

The formula, which corresponds almost exactly with these analyses, is $Co\ S_2$ $Co\ Sb_2$; $Ni\ S_2$, $Ni\ Sb_2$, the mineral being a sulph-antimonide of nickel and cobalt. A sulph-antimonide of nickel (ulmannite) is already known, and in Dana's "System of Mineralogy," one specimen of it is mentioned as containing

1·06 per cent. of cobalt. Ulmannite has been found in South Australia, but never, so far as I am aware, in this Colony. The presence, however, of such a large and apparently constant percentage of cobalt in the Broken Hill mineral seems to justify its recognition as a new species, and I have accordingly given it the name of Willyamite (pronounced Willy-ah'-mite), after Willyama, which is the official name of the Broken Hill township, and which, in the language of the Aborigines, means "a hill with a broken outline."

The following are the physical and pyrognostic characters of Willyamite:—*System of crystallisation*—Isometric. *Cleavage*—Cubic, perfect. *Fracture*—Uneven, brittle. *Hardness*—About 5·5 *Specific gravity* (mean of a number of experiments) —6 87. *Lustre*—Metallic. *Colour*—Between tin-white and steel grey. *Streak*—Greyish-black. In the closed tube, and next to the assay, yields a dark red sublimate, which is orange-coloured in cooling, and this is surmounted by a faint white sublimate. In the open tube decrepitates, yields antimonial and sulphurous fumes; near the assay the white sublimate shows in fern-like forms. Before the blowpipe on charcoal fuses readily to a globule, which boils and emits sulphurous and antimonial fumes. With borax glass gives at first the cobalt-blue colour, but after oxidising all the cobalt the nickel reaction is obtained. Decomposed by nitric acid with separation of antimony trioxide.

VI.—On a Vertebra from the Wellington Caves: by W. S. Dun, Assistant Palæontologist and Librarian.

[Plate V.]

I.—*Introduction.*

The specimen about to be described was found by Mr. James Sibbald, Keeper of the Wellington Caves, in the calcareo-ferruginous cave breccia of No. 4 Cave, in 1892, together with a large number of remains of extinct marsupials. The specimen is so well preserved that it was thought that a short description and figure of it would be of use for purposes of comparison. The vertebra is clearly one of the cervical region, and its great size separates it from any known extinct marsupial, except *Diprotodon*, *Nototherium*,* *Euowenia*, *Phascolonus*, and *Palorchestes*. From the form, which is described later on, it will be seen that

* I include under this generic name *Zygomaturus*, which is considered by Mr. De Vis, and was likewise by the late Gerard Krefft, to be separate from *Nototherium* in opposition to the opinion of the late Sir R Owen. For a discussion of this subject, *see* R. Lydekker, *Ann. Mag. Nat. Hist.*, 1889, iii (6), pp. 149–152

the reference of it to *Phascolonus* or *Palorchestes*, members of the families Phascolomyidæ and Macropodidæ respectively, is out of the question, and the only known genera to which it can belong are *Diprotodon*, *Nototherium*, and *Euowenia*. At present *Euowenia* is known from remains of the jaw only, so that the relations of the bone in question to the latter cannot be entered into at the present time. Remains of *Diprotodon* are fairly common in the Wellington Caves, indeed it was there that Sir Thomas Mitchell obtained the specimens on which the genus was founded.* Remains of *Nototherium* do not seem to have been so common, no specimens having as yet been described from these caves. The late Mr. C. S. Wilkinson mentions *Nototherium Mitchelli*, *N. Victoriæ*, and *N. Krefftii* as occurring there,† but I am not acquainted with the source of his information. The late Mr. Gerard Krefft, Curator of the Australian Museum, in his report on the specimens of vertebrate remains collected under the supervision of the late Professor Thompson and himself in 1869,‡ gives the following items under the head of *Zygomaturus*—part of a second upper molar, and a right upper premolar—and adds, "There is in the Museum collection a splendid series of fossil remains, indicating at least two new species of the above genus, but as the list comprises Wellington specimens only, they are not enumerated here."§ He makes no mention of *Nototherium* (in the restricted sense) in this report as occurring at Wellington. As far as the vertebræ of *Nototherium* are concerned I am only acquainted with Sir Richard Owen's description of the atlas, so that the only vertebra with which it can be absolutely compared is that of *Diprotodon australis*; and, as will be shown later on the evidence seems to be sufficiently strong to refer it to *Diprotodon*.

II.—Description.

The vertebra is well preserved, portion of the neural spine and parts of the transverse processes being the only portions destroyed. Sufficient of the neural spine is preserved to show that it was directed backwards with a slight curve, and is slightly compressed in a lateral direction. The articular surface of the anterior zygapophysis is not so elongated as in *Macropus*, and is perfectly flat, and not slightly curved as in that genus; it is only very slightly inclined from behind forwards, not to a great degree as in *Phascolarctos*. The posterior zygapophysis is somewhat larger than the anterior; the inner border is slightly raised and continues to the base of the diapophysis. The surface of the posterior zygapophysis is slightly lower than that of the anterior and does not slope inwards to such an extent. The lower portion of the neural arch—the neurapophysis of Owen—gives rise to a fairly thin but well-developed diapophysis, which, together with a strong parapophysis, enclose the very well developed vertebrarterial canal, and join to form the transverse

* Three Expeditions into the Interior of Eastern Australia, &c., II, pp. 362-363, t. 31, f. 1 and 2. (8vo. London, 1838).
† Min. Prod. N. S. Wales, 2nd Ed., 1887, p. 90.
‡ Exploration of the Caves and Rivers of N. S. Wales (Minutes, Reports, &c.) N. S. Wales Parliamentary Papers, 132—A. 1882, pp. 8-13. (Folio, Sydney. By Authority).
§ *Loc. cit.* p. 9.

process, the remains of which show it to have been directed posteriorly. The centrum is ellipsoidal in shape and slightly bi-concave, and in its shortness seems to be far removed from the Macropodidæ, and to approach more nearly to the Phascolomyidæ. There is a well-marked venous opening on the upper surface of the centrum. The anterior aspect of the neural arch shows considerable roughening at the base of the neural spine, and there is a well-marked hollow immediately over the hinder border of the anterior zygapophysis. There is no sharply-marked ridge along the aspect of the neural spine. Viewed posteriorly, one point that is very noticeable is the well-marked groove between the centrum and the base of the neurapophysis, and which was pointed out by Sir Richard Owen as being so well developed in *Diprotodon australis**—the "conjugational foramina"; this is present though less marked on the anterior side. On the median line between the two posterior zygapophyses is a well-marked ridge arising from the ledge that forms the posterior of the summit of the neural canal. This ridge is only faintly continued along the neural spine. The sides of the neural arch slope forward. Just in front of the right posterior zygapophysis, on the inward slope of the neural arch, is a well-marked depression which does not occur on the other side. The vertebra gives the following measurements in millimetres :—

Centrum, length	34
„ depth, anterior face...	54
„ width	70
Neural canal, height	25·5
„ width	50
Vertebraterial canal, width	16
„ depth	13
Neural arch, thickness	28
Neural spine, thickness at 28 mm. from neural canal	22
„ „ antero-posterior	26·5
Posterior zygapophysis, length	35·5
„ „ breadth	30·5
Anterior „ length	31·5
„ „ breadth	29·5

On the whole the general characteristics of the vertebra lead to the conclusion that it belongs to *Diprotodon*, most propably *D. australis*, Owen. Nothing as yet is known of the vertebræ of *Diprotodon minor*, Huxley,† or *D. longiceps*. M'Coy,‡ the jaws alone of these two species being known. A comparison of the figures of this specimen with those given by Sir Richard Owen of the third cervical vertebra of *Diprotodon australis*§ will show great agreement in every respect except that

* Phil. Trans., 1870, p. 542.
† Quart. Journ. Geol. Soc., 1862, XVIII, pp. 422-427.
‡ Prod. Pal. Vict., 1876, Dec. 4, pp. 7-11.
§ Phil. Trans., 1870, t. xliv, fig. 4; Foss. Mam. Austr., 1877, t. 29, fig. 4.

of size, which is most probably due to difference of age or of sex of the individuals to which they belonged. The description and woodcut also given* agree with that of our specimen, with very slight exception, for instance in the slight lateral compression of the neural spine, which does not prevail in the type specimen. The form and inclination of the neural spine and the general form of the vertebra as seen in a side view show it to be more like the third cervical as figured in the above-mentioned woodcut than either the fourth, fifth, or sixth, so that it seems safe to refer to that position in *Diprotodon*, leaving the specific determination in abeyance.

VII.—On the Occurrence of an Auriferous Raised-beach at the Evans River, Co. Richmond, N. S. Wales: by G. A. STONIER, F.G.S., Geological Surveyor.

THE Evans River, known locally as the Little River, is in the north-eastern portion of N. S. Wales, and rises behind the township of Woodburn, Parish of Riley, Co. of Richmond, flowing to the east into the Pacific Ocean. On its northern bank there is a wide, somewhat fan-shaped, flat which extends to the Richmond River and is formed partly of freshwater alluvium (the rich agricultural soil of the district), and partly covered by blown sand. To the south-west there is an extensive development of sandstones and shales of the Clarence Coal-measures, considered to be of Triassic age; at the mouth of the river the sandstones, &c., with a boss of felsite, form a large headland, but coming south along the coast the rock is lost under a covering of blown sand which occupies, at a distance of three miles from the river, an area somewhat lozenge-shaped, and measuring nearly three miles in its greatest breadth and seven miles in length, as far as examined. The sand is arranged in lines of dunes, one of which reaches one hundred and thirty feet in height and forms a range of hills a couple of miles in length; others are in the form of ridges and eminences separated by swampy flats. The area is bounded on the west by sandstones of the Coal-measures and on the east by the ocean beach, while at Bullock Creek, about the centre of the formation, a small inlier of slate of Lower Carboniferous (?) age makes its appearance.

Gold has been obtained along the coast for many years from Port Macquarie to the Queensland Border, and at the Evans River is now being obtained from (1) present sea-beach, (2) a slightly raised sea-beach, (3) "back terrace" (probably a raised sea-beach). The first named consists only of the streaks of black sand

* Phil. Trans., 1870, p. 542, fig. 5; Foss. Mam. Austr., 1877, p. 212, fig. 5.

which are usually worked by beach-fossikers. No. (2) occurs immediately at the back of the beach, which is narrow and inclined and often covered by surf; the deposit, which has been worked in patches for about two miles, is covered by drift-sand varying in thickness from three to sixteen feet. As none of the claims were working the pay-dirt, there was no opportunity for measuring its thickness; some patches have been very rich—one small claim yielded one thousand ounces of gold—and although there are several months of work practically in sight for two or three claims, the bulk of the gold has been won.

The "back terrace" (3) has been recently found, and the discovery has opened up new possibilities for mining in the district. The deposit, which consists of black sand and is probably an old sea-beach, is situated a quarter of a mile inland from the coast, and is about six feet above ordinary high-water mark. It has been traced for some four miles in length, and, though doubtless continuous at one time, it has been denuded and now occurs as outliers, covered by blown sand up to twenty-feet in thickness. Four of these patches have been discovered, and one of them has been proved to be a couple of hundred yards in length, but the others require to be further tested before their length can be measured. The black sand varies from one to five feet in thickness with a decided dip seawards, and is generally thickest in the centre, slightly tapering off at the sides. Under the microscope it is seen to consist of minute grains of quartz and a little topaz with fine specks and pellets of ilmenite (titanic iron), gold, tin, platinum, osmium, iridium (possibly other platinoid metals), a little magnetite, limonite, and small garnets (?); occasionally a few flat sandstone pebbles occur, the largest usually found measuring one foot by eight inches by two inches; the colour of the sand varies from whitish-grey to black. The quartz grains are opaque and white with a large sprinkling of pieces of rock crystal; a few show traces of crystalline facets, but most of them are well-rounded, some resembling in shape the pencil-tourmaline common in the New South Wales diamond-drift. As a rule the black sand rests upon and at the sides passes imperceptibly into a white sand, which consists chiefly of fine and well rounded quartz grains, and overlies a consolidated, in places quite hard, peaty sand representing probably an old land surface, as do many similar sections in the æolian deposits about Sydney. No attempt has been made to prove the formation below this hard sand-rock.

The gold, which is exceptionally pure, and brings £4 2s. 3d. per ounce, is very fine, and appears to be free from "rust"; most of the specks are somewhat shotty, but there is also a certain proportion of float-gold.

The platinum is of steel-grey colour, and occurs as minute flat specks with a metallic lustre, and of a more or less longitudinal section, occasionally turned up at the edges. Osmium, iridium, and probably other platinoid metals are found, but in varying proportions. Tin has been found in minute grains and of small percentage.

The method adopted for saving gold has hitherto been of the simplest kind, but there is a likelihood that an attempt will be made to concentrate and separate all the marketable minerals. The claims are worked only for gold, and those which are favourably situated are returning more than wages; other claims have failed to pay, partly because the gold is somewhat patchy and partly on account of the expense entailed when the stripping, some twenty-five feet, has to be raised to the surface, and the construction of a tail race is impossible.

The three deposits to which reference has been made are the only ones that have been yet discovered, but there is much speculation as to the existence of other beaches, and with the evidence all along the coasts of New South Wales and Queensland of elevation at various times, it is but fair to conclude that there may be further traces of old beaches; the evidence of subsidence is not so conclusive, but the formation cannot be considered to have been proved until the bed-rock has been touched at carefully selected sites. Owing to the quantity of water which may be met with, and the thickness, some forty feet in places, of loose sand to be sunk through, it will not be an easy matter to put down shafts to the bed-rock; the work would be more easily performed with a sludger.

The difference in value between the beach and terrace gold is interesting; the former brings £3 16s. 0d. and the latter up to £4 2s. 3d. per ounce, so that it is likely that there are two sources from which the gold has been derived. The late C. S. Wilkinson* states that at Ballina the gold and platinum have been derived from the denudation of a sheet of basalt, which has been proved by bulk crushings to be auriferous. At the Evans River some of the gold may have come from basalt, although the Ballina sheet does not appear to extend so far south; another source may readily be found in quartz veins traversing slates, which make only a small outcrop on the field, but are largely developed in parts of adjoining districts.

A further reference will be published in the "Annual Report of the Department of Mines and Agriculture for 1894."

* Ann. Report Dept. Mines N. S. Wales for 1889 [1890], p. 203.

VIII.—On the Occurrence of a *Pteronites (P. Pittmani*, sp. nov.) in the Spirifer Sandstone of Warrawang, or Mount Lambie, near Rydal: by R. ETHERIDGE, Junr., Palæontologist and Librarian.

[Plate VI.]

I.—Introduction.

THE comparatively meagre fauna hitherto found associated with the Mount Lambie Spirifer Sandstone renders any augmentation valuable, more particularly when the addition is in comparatively large numbers. The only Mollusca so far published from this horizon are *Spirifera disjuncta*, *Rhynchonella pleurodon*,* and "*Pecten*, *Orthis*, *Murchisonia*, *Modiola*,"† the two first named being very common and characteristic. I now desire to place on record the occurrence of a well marked shell, resembling in some respects the genus *Aviculopinna*, Meek, but more especially *Pteronites*, McCoy. This, it is proposed to name *Pteronites Pittmani*, in honour of the Government Geologist, who, in company with Professor T. W. E. David, collected the specimens.

II.—General Description.

The fossils occur as casts of the exterior, not impressions in the strict sense of the word. The shell is transversely elongated, pinnaform, sub-compressed, with a straight hinge line, or cardinal margin, extending the entire length of the shell. The ventral edge is obliquely sloped from the anterior end downwards, and insensibly passes upwards into the posterior edge, which in its upper course becomes slightly emarginate. The bodies of the valves are most convex—but not greatly so over any portion of their surface—in a line drawn immediately from the umbones towards what would be the posterior ventral angles, but the convexity is confined to the anterior thirds of these lines. The cardinal margin in each valve is quite straight, and at its outer termination forms at the junction with the posterior edge an acute point. The anterior end is small, but very well defined, lobe-like, and acutely pointed; the posterior end in each valve becomes flattened. The umbones, as distinguished from the beaks,‡ are convex, and raised slightly above the level of the cardinal margin. The sculpture consists of numerous concentric laminæ, becoming emarginate on the posterior end, following the outline of its edge. They become coarser towards the ventral margin, and there are always a few very well-marked along its whole length. There are no radiating costæ.

No traces of internal structure are apparent, except on two specimens. On one, a slight and delicate thickening along the cardinal margin is apparent, and on

* De Koninck, Foss. Pal. Nouv.-Galles du Sud, Pt. 2, 1876, pp. 95 and 100.
† C. S. Wilkinson, Geol. Map of the Districts of Hartley, Bowenfels, Wallerawang, and Rydal, 1875, Ref. note 11 (*Dept. Mines, Sydney*, 1875).
‡ I retain the word "beaks" for the immediate apices of the umbones

another, what may be a cast of the posterior muscular impression, as a small circular eminence on that region of the posterior end, where this scar should occur. I have not succeeded in establishing the presence of a byssal sinus.

III.—Generic Affinity.

Three genera are open to discussion in this respect, *Pteronites*, *Aviculopinna*, and *Palæopinna*. It entirely agrees with M'Coy's definition of *Pteronites*,* except in the rather more pronounced anterior end, and absence of a byssal sinus. With *Aviculopinna* it accords perfectly in outline, closely resembling the little American *A. americana*, Meek,† but is unlike the German *A. pinnæformis*, Geinitz, sp.,‡ which does not possess an emarginate posterior end, but exhibits radiating costæ. On the other hand, in outline it is equally akin to *Pteronites angustatus*, M'Coy,§ of the Irish Carboniferous Limestone, but the latter is a much more slender shell, has a smaller anterior end, and no posterior emargination. *Pteronites latus*, M'Coy, may also be cited as a somewhat similar shell. The truncate anterior end in Hall's *Palæopinna*, such as *P. flabella*,** of the Chemung Group, at once separates our fossil from that genus. But of all the forms with which I am acquainted, *Pteronites profundus*, Hall†† appears to be the nearest ally, even to the small pointed anterior end. *Pteronites Pittmani*, however, is not so deep a shell from the cardinal to the ventral margin, and is proportionately more transversely elongated.

IV.—Specific Diagnosis.

Pteronites Pittmani—*Sp. nov.*

(Plate VI.)

Sp. Char. Shell transversely elongated, pinnaform; cardinal margin straight, extending the whole length of the shell; posterior slope somewhat convex towards the anterior, and shading off into the posterior end. Ventral margin carving obliquely downwards and insensibly passing into the posterior margin, which is shallowly emarginate above. Anterior end small, lobe-like, pointed; posterior end flattened. Umbones convex, raised slightly above the cardinal margin. Apparently no byssal sinus. Posterior muscular impression (?) small, circular. Sculpture of concentric laminæ, parallel to the margin, becoming convex below, but no radiating costæ.

Obs. Named in honour of Mr. E. F. Pittman, A.R.S.M., Government Geologist of New South Wales. The nearest ally is *Pteronites profundus*, Hall, of the Chemung Group of North America (Upper Devonian.)

Hor. and Locality.—Solitary Creek, at Ferngrove, near Warrawang, or Mount Lambie, near Rydal, Co. Cook (*E. F. Pittman* and *T. W. E. David*)—Spirifer Sandstone, Upper Devonian.

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* Synop. Carb. Lime, Foss. Ireland, 1844, p. 81.
† Hayden's Final Report Geol. Survey E. Nebraska, 1872, p. 197, t. 9, f. 12, a-d.
‡ Dyas, Heft, I, 1861, t. 14, f. 1-4.
§ *Loc. cit.*, p. 81.
** Pal. N. York, 1884, V, Pt. I, No. 1, t. 25, f. 18.
†† Pal. N. York, 1884, V. Pt. I, No. 1, t. 32, f. 25-27.

IX.—On Fuller's Earth from Wingen: by GEORGE W. CARD, A.R.S.M., F.G.S., Curator and Mineralogist.

A SAMPLE of unctuous clay from Wingen has been found to possess the characteristics of Fuller's Earth. When received the clay was very wet and soft, but not plastic. It dried very slowly in the air and became friable. The colour may be described as yellowish-green; when moderately heated it becomes colourless, finally fusing to a green glass. The lustre of a cut surface is shining. It does not adhere to the tongue. Under water it softens and falls down, and can then be used with excellent effect for cleansing purposes. The general appearance is somewhat suggestive of some of the material obtained from Bedfordshire, England.

An analysis (2394/93) of an air-dried sample, made by the Assayer and Analyst gave results as follows:—

Moisture	13·73
Combined water	6·45
Silica	50·61
Alumina	19·35
Ferric oxide	3·55
Ferrous oxide	nil.
Manganous oxide	nil.
Lime	1·37
Magnesia	3·24
Potash	·92
Soda	·47
Phosphoric anhydride	trace.
Sulphuric anhydride	nil.
	99·69

Mr. Tom S. Walsh, of Wingen, has kindly supplied the Author with the following particulars as to the mode of occurrence of the deposit. A bed of sandy clay, containing plant-impressions, is succeeded by a very thin (three inches) band of carbonaceous clay, underlying which is the Fuller's Earth. The earth constitutes a bed varying from thirty-two to thirty-six inches in thickness and very nearly horizontal. Another thin band of carbonaceous earth succeeds, and is followed by sandstones. The clay crops out on the bank of a small stream; the sample was taken close to the outcrop.

As this appears to be the first recorded occurrence of Fuller's Earth in New South Wales, a few remarks will be offered on its uses and sources of supply.

The importance of the earth for the cleansing of cloth from grease was at one time so great that its exportation from England was prohibited by Act of Parliament.*

* "The British Legislature, therefore, have, from the days of Charles I., guarded against the exportation of it under severe penalties." Journey from Chester to London by Thomas Pennant, 1811. (Quoted by Mr. A. C. G. Cameron—*Proc. Geol. Assoc.*, XII, p. 399, footnote.)

It is now made use of in a variety of other ways; in the cleansing of many articles; in the preparation of ultramarine; in the manufacture of various toilet and curative articles; and, more particularly, in the clarification of lard, for which purpose a large quantity is exported to America.

The action of Fuller's Earth upon water is of considerable importance. As will be referred to below, the water used in Somersetshire for washing the crude earth is found to be softened and purified. The water thrown out by the beds in Bedfordshire is similarly affected. The villagers throw blocks of it into their wells, and it is stated* that it is also carried to the Fen District to be used as a filter for clarifying the peaty water.

The following table, compiled from the 'Mineral Statistics of the United Kingdom,' gives the quantities raised in England in 1891 and 1892, with the value at the mines:—

	1891.		1892.	
	Tons.	Value.	Tons.	Value.
Bedfordshire	671	£756	3,703	£4,166
Somersetshire	6,004	£7,506	4,965	£4,300
Surrey	4,500	£10,300	755	£750

It will be noted that the price varies from one to two pounds per ton; but the market is said to be controlled by a "ring."

During a recent visit to the Bedfordshire Mines the Author obtained the following information.

The beds of Fuller's Earth occur in the Lower Greensand formation of the Cretaceous Series; they are about ten feet thick and are sinuous in section—nearly horizontal, but not straight. Regular mining operations are carried on, the galleries being extensively timbered. When raised the clay is dried in kilns and pulverised by an American "Cyclone" mill. The beds are alternately yellow and blue in colour.

At Midford, in Somersetshire, the Fuller's Earth occurs in the Fuller's Earth formation of the Jurassic Series, and is from four to seven feet thick. The colour is yellow at the outcrop and blue beneath. It is worked by galleries driven into the hill-side. The process of preparation for the market differs here from that employed in Bedfordshire. "The raw earth . . . . is ground up (in a 'pug-mill') with about three times its own bulk of water. The compound, known as 'slurry' is then turned into a series of little tanks or 'catch-pits,' and while the finer Fuller's Earth remains in suspension the coarser particles sink to the bottom. The liquid, which still contains some impurities, is then allowed to run

* Proc. Geol. Assoc., XII, p. 399.

into a long earthenware drain, laid underground, which conveys it to the works more than half-a-mile distant. Here the turbid water flows into a long shallow trough called a 'maggie,' and the coarser particles still contained in it subside and are caught by a series of little wooden steps placed across the bottom of the trough. By these processes the Fuller's Earth is purified. It is now run into large tanks, and the suspended earth is allowed to settle gradually; while the surface water that is drained off is said to be very soft, pure and drinkable. These operations take about thirty days, and now a damp, clayey mass remains in each tank. This material is removed to a large drying shed, where, by means of a furnace and hot-air flues, it is thoroughly dried, and is then ready for the market."*

At Nutfield, in Surrey, the beds also occur in the Lower Greensand, and are about twelve feet thick. As in Bedfordshire and Somersetshire, the colour is blue and yellow.

A number of analyses of Fuller's Earth have been made, and full details of them for Bedfordshire and Somersetshire will be published shortly in 'Memoirs of the Geological Survey of Great Britain.' These show that the detergent properties of the earth are not dependent upon composition, but must be related to its mechanical condition. The blue and yellow varieties are, speaking generally, equally valuable.

X.—Palæontologia Novæ Cambriæ Meridionalis. — Occasional Descriptions of New South Wales Fossils, No. 1: by R. ETHERIDGE, Junr., Palæontologist and Librarian.

[Plate VII.]

UNDER this title it is intended to give, as opportunity offers, brief notes on fossils found in New South Wales.

1. *Further Traces of* SCHIZONEURA.

Pl. VII, Fig. 1.

The fragmentary plant represented in Pl. VII, Figs. 1 and 2, is regarded as a possible confirmation of the occurrence of *Schizoneura* in our lower rocks of Triassic age. The other possible reference is to *Phyllotheca*, but the balance of evidence seems to be in favour of the former genus. The specimen consists of a transverse section of a circular stem, with portions of two leaves and traces of the base of a third given off in a verticillate manner. Each of the lanceolate leaves is split after the manner of *Schizoneura*, a feature that was not apparent in my figure† of the Bulli specimen. This has, however, been excellently explained by O. Feistmantel in the case of the Indian *S. gondwanensis*. It may be contended that as *Schizoneura* possesses but two leaves

* Proc. Geol. Assoc., XIII., pp. 126-127.
† Records Geol. Survey N. S. Wales, 1893, III, Pt. 3, p. 74.

opposite one another,* and there are traces of three in our example, the latter cannot be well referred to the Indian genus. Yet, on reference to other figures† of Feistmantel's, it will be seen that when the leaves are broken up into their component parts they assume a verticillate appearance, forming a series of strap-shaped segments radiating from the entire periphery of the stem, and thereby assuming the position represented in Pl. VII, Fig. 1. This would be naturally increased if these leaf-portions in *S. gondwanensis* were pressed from above downwards, as in the present case. The chief factor against the reference of this fossil to *Schizoneura* lies in the absence of the distinctly marked wide-apart veins.

Turning now to *Phyllotheca*, we may remark that in *P. australis*, Brong., the leaves are long, linear, and pointed, and it is quite possible that the next form but one is identical with this. In *P. ramosa*, McCoy, the leaves forming the free edges of the sheaths are very numerous, fine, and short‡; whilst in *P. Hookeri*, McCoy, they are, although equally plentiful, long and proportionately fine and narrow§. Moreover in all these species, each leaf is provided with a central mid-vein. This delicacy of the leaves seems to be an almost universal feature of *Phyllotheca*. Without, therefore, insisting on the identity of our plant fragment with *Schizoneura*, I think it well to regard it as such for the present, and in some degree confirmatory of my former determination.

The specimen is of more than ordinary interest from its occurrence at a much higher horizon in the unproductive beds between the uppermost coal seam of the Upper Coal Measures and the Hawkesbury Sandstone in the Second Cremorne Bore, Shell Cove, Port Jackson, at a depth of one thousand two hundred and seventy-four feet six inches. In other words, in a portion of the olive-green shales of the Narrabeen Series. Collected by Mr. E. F. Pittman, A.R.S.M.

Sir F. McCoy has called my attention to an oversight in my remarks on *Schizoneura australis* in connection with determinations of his own, for which I express regret. In his 'Report on the Palæontology of the Geological Survey [of Victoria] for the year 1891,' he mentions his recognition of Lower Triassic rocks of Bunter Sandstone age, at Bacchus Marsh, in the following words:—"For this determination I have only a few fragmentary examples filled with comminuted plant remains from a newly discovered bed, just under the famous *Gangamopteris* sandstone of Bacchus Marsh. . . . One of the plant fragments seems clearly to indicate a *Schizoneura*, and if this determination be borne out by additional specimens, which should be procured, the indication will be the addition to the Geological Map of Victoria of the Lower Trias formation, or Bunter Sandstein," &c.‖ It will be observed that the specimens are spoken of as comminuted.

* Pal. Indica (Gondwana Flora), 1880, III, No. 2, Pt. 1, t. 4a.
† *Ibid*, t. 7a, f. 2, &c.
‡ Ann. Mag. Nat. Hist., 1847, XX, t. 11, f. 2.
§ Ann. Mag. Nat. Hist., 1847, XX, t. 11, f. 4, 5.
‖ Ann. Report Secy. for Mines Vict. for 1891 [1892], p. 30.

2. SAGENOPTERIS (?) *in the Narrabeen Series.*

Sagenopteris salisburoides, Johnston ?

Pl. VII, Figs. 2 and 3.

Sagenopteris salisburoides, Johnston, Proc. R. Soc. Tas. for 1886 [1887], p. 170.

" Johnston, Syst. Acc. Geol. Tas., 1888, t. 28, f. 4 and 4a.

Sagenopteris (?) salisburoides, Feistmantel, Uhlonosné útvary v Tasmánii, 1890, p. 100, t. 9, f. 1, 1a.

Obs.—Mr. R. M. Johnston has figured this plant, and Feistmantel has copied his figures, under two forms—a palmate or flabellate entire frond, and a similar shaped leaf broken up into four rather cuneate lobes, with a distinctly Sagenopteroid venation. The plant represented in Pl. VII, Figs. 2, displays a leaf of the first order with an entire margin, and in Fig. 3, one more or less segmented, with the edge further subdivided. The degree of variation shown in Johnston's figures will, I believe, admit the present leaves within his species. The venation seems identical, the nervules springing from two or three prominent nerves at the base of each leaf, and then anastomosing to form a delicate mesh. In Fig. 3 the leaf is attached to a stem that is prolonged upwards, but is not absolutely continuous with the higher portion, giving off two terminal leaves or pinnules, similarly veined. The attachment of the main leaf is a definite one, and as the smaller wedge-shaped leaves are similarly reticulated, they are presumed to be one and the same. If this plant really be a *Sagenopteris*, the form of the frond, so far as preserved, forces on us a somewhat different conception of the method of attachment of the pinnules and branching of the stem to that usually met with in the genus.

The specimen was collected by Mr. E. F. Pittman, A.R.S.M., from the same locality and series as the last fossil, at a depth of one thousand four hundred and ten feet to one thousand four hundred and seventeen feet six inches.

3. SPIRIFERA DUODECIMCOSTATA, *McCoy.*

Pl. VII, Figs. 4–8.

Spirifera duocecimcostata, McCoy, Ann. Mag. Nat. Hist., 1847, XX, p. 284, t. 17, f. 2 and 3.

Spirifer duodecimcostatus, Dana, Wilkes' U. S. Explor. Exped., 1849, X (Geol.), p. 684, Atlas., t. 2, f. 1, a and b.

Spirifer duodecimcostatus, De Koninck, Foss. Pal. Nouv.-Galles du Sud, 1877, Pt. 3, p. 254 (*excl. figs.*)

Obs.—An opportunity is afforded me of figuring the almost complete form of this species, and its surface sculpture. The general characters have been sufficiently well described by Profs. McCoy and De Koninck. In the first place it will be noticed (Pl. VII, Fig. 5.) that the area is very wide, triangular, extending the whole length of both valves, and is transversely striated and vertically lined.

The fissure is very large and widely triangular. The surface bears numerous imbricating laminæ of shell growth, wide apart above, but following one another with great rapidity towards the front. The surface of the laminæ is occupied by innumerable wavy microscopic concentric lines, and these are crossed by equally plentiful and delicate radiating lines (Pl. VII, Fig. 6), both on the costæ and in the intercostal spaces, producing the finest possible reticulation. Over the whole was a thin epidermal covering of a fibro-punctate rugose nature, consisting of very minute elongately tear-shaped pustules (Pl. VII, Figs. 7 and 8).

We are indebted for the original of Figs. 4 and 5 to Mr. John Waterhouse, M.A., Inspector of Schools, who obtained it from the hard nodular concretions of the Upper Marine Series, struck in the Maitland Colliery Co.'s Shaft, near Farley, Co. Northumberland. The surface ornament is drawn from an example collected by Mr. J. A. Wall, from the Upper Marine Series at Gerringong, Illawarra.

4. *Additional Evidence of* ENTOLIUM.

Genus Entolium, Meek, 1865.

Pl. VII, Fig. 15.

Entolium, Meek, Pal. California, 1865, App. 1, p. 478.
„ Meek, Hayden's Final Report, Geol. Survey Nebraska, 1872, p. 189.
„ Etheridge fil., Ann. Mag. Nat. Hist., 1878, p. 30.
Pernopecten (pars), Hall, Pal. N. York, 1885, V, Pt. 1, No. 2, pl. VII.
Entolium, De Koninck, Ann. Mus. R. Hist. Nat. Belg., XI (Faune Calc. Carb., Pt. 5), 1885, p. 240.
„ (*Pernopecten*), Etheridge fil., Geol. Pal. Queensland, 1892, p. 264.

Obs. In common with other observers I have always used the name *Entolium* for this group of shells (Pl. VII., Fig. 15), but Professor James Hall has endeavoured to show the identity of Meek's genus with *Pernopecten*, Winchell, in his remarks cited above. Without entering on all the details of the subject, there lucidly set forth, it will be sufficient to say that Winchell's type, *Aviculopecten limiformis*, White and Whitfield (non Morris), in addition to its other peculiarities, bears a series of every minute crenulations on the hinge-plate. But the shell selected by Meek as the type of his genus, *Pecten demissus*, Phill., is devoid of these crenulations, although in other respects agreeing with *A. limiformis*. Hall remarks that in the latter the crenulated hinge-plate is "often obscure or concealed, and the crenulations are easily abraded by friction." I have never seen such a structure on any of the numerous European examples of *Entolium* that have passed through my hands, nor on the limited number of Australian—and Professor De Koninck's evidence was clearly similar, for he says that *Pernopecten* seems to differ from *Entolium*—"by the existence of a series of tubercles along the cardinal margin" (=hinge-plate of Hall). Either, therefore, Hall's view of the rapid abrasion

of these crenulations is correct, or we have, following Meek and De Koninck, two distinct types, one with, and the other without a crenulated hinge-plate. This is, at present, my opinion, and leaving the final solution to those in possession of more satisfactory material, I tentatively retain *Entolium* for shells similar to *Pecten demissus*, Phill., and *Aviculopecten Sowerbii*, M'Coy, the British types. This is perfectly justifiable until the latter and their Australian brethren have been proved, which at present is not the case, to possess the crenulations of *Pernopecten*.

We are acquainted with this genus from two localities in New South Wales, both in the Carboniferous, or at any rate, in rocks believed to fall into this series.

The figured valve (Pl. VII., Fig. 15) is oval, longer than broad, narrowing towards the cardinal margin and slightly oblique. The ears are nearly equal, horizontal, and not elevated above the umbone; the ligamentary pit shallow, but the transverse furrows in the ears are not visible. The surface is covered with fine concentric and very numerous lines, but no radiating lines or costæ.

In general form the present shell approaches *E. aviculatum*, Geinitz, sp., and *E. Sowerbii*, M'Coy, sp., more than any others, except that the ears are not elevated-conate, for possibly it is a right valve. To some extent also it resembles *E. coloratum*, De Kon. It was collected from the Carboniferous beds of Somerton, Co. Parry, by Mr. Charles Cullen, of the Geological Survey of N. S. Wales.

The second example of *Entolium* is also a single valve, with the ears slightly elevated; the umbo small and delicate; the impressions of the long diverging teeth well preserved, dividing off the well-flattened sides of the valve. The thin papyraceous test bears fine, numerous, concentric lines as usual. This example was found by Mr. J. Waterhouse, M.A., in the Mirari Limestone, Dungog Road, nineteen miles from West Maitland, Co. Durham. I refrain, in anticipation of additional material, from applying a specific name to these shells.

5. *Further Structure of* GONIATITES MICROMPHALUS, *Morris, sp.*

Goniatites (*Prolecanites*?) *micromphalus*, Morris, sp.

Pl. VII., Figs. 9–14.

Bellerophon micromphalus, Morris, Strzelecki's Phys. Descrip. N. S. Wales, &c., 1845, p. 288, t. 18, f. 7.

" " Dana, Wilkes' U.S. Explor. Exped., 1849, X (Geol.), p. 708, t. 10, f. 6, *a* & *b*.

Goniatites micromphalus, De Koninck, Foss. Pal. Nouv.-Galles du Sud, 1877, Pt. 3, p. 339, t. 24, f. 5.

Obs.—Although more than one good description of the form of this species has appeared, yet so far as I know, the surface sculpture has not been described, nor have the septa been noticed. Several excellent specimens collected by Messrs. David and Waterhouse enable me to supply this deficiency to some extent.

The old growth stages are usually well shown in *G. micromphalus*, and judging from the backward re-entering angles in the middle line, the latter appear to have been much more acute in the younger than the older state, and to have become more openly curved as age progressed until, in that condition attained by one of the specimens now before me, the lip displays only a feeble sinuosity.

The sculpture consists of microscopic spiral and transverse lines, breaking the surface into a series of the smallest squares, presenting, when magnified, the appearance of a toothed or rasplike surface. The sutures are moderately close, but in no instance is the shell sufficiently clear of its cover to expose the lobes and saddles of an entire suture, but the accompanying figure (Pl. VII, Fig. 12) will convey an idea of the form and general appearance of these interesting details. Both the lobes and saddles are nearly similar in shape, broadly sagittiform, or somewhat club-shaped (sub-pyriform). As the ventral lobe is not visible the section to which this species belongs cannot be determined with certainty, but probably it falls within Hyatt's Prolecanitidæ, and may be referable either to *Sandbergeroceras*, Hyatt,* or *Prolecanites*, Mojsisovics. † The first is equal to the section Linguati of the Bros. Sandberger, and the latter to the Lanceolati of the same authors, or Æquales of Beyrich. On the other hand our shells have not a large umbilicus as in *Sandbergeroceras*, and the surface is not smooth as in *Prolecanites*. On the whole, and omitting from consideration the ventral lobe, they seem to come nearer to the latter. The lobes and saddles have quite the appearance of *Goniatites Henslowi*, Sby., ‡ and *G. serpentinus*, Phill., § both Carboniferous species, and now referred to this section. One other pecularity exists in this Goniatite, the existence of a more or less oval scar, visible when the sculpture layer has been removed from the shell. This always occurs on the back, or ventral side, just above the penultimate growth stage, or false mouth. It has the appearance of a gradual peeling off of successive layers of shell structure, and is present in several examples. It must therefore have some structural significance.

The present specimens of *G. micromphalus* were obtained from the Upper Marine Series (hard calcareous concretions), at the Maitland Colliery Co.'s Shaft, near Farley, and the Melbourne Coal Co.'s Shaft, at Richmond Vale, near East Maitland, by Professor T. W. E. David, B.A., and Mr. J. Waterhouse, M.A.

* Proc. Boston Soc. Nat. Hist. for 1882-83 [1884], XXII, p. 333.
† *Ibid*, p. 335.
‡ Phillips, Ill. Geol. Yorkshire, 1836, t. 20, f. 39.
§ *Ibid*, t. 20, *f.* 48-50.

PLATE I.

Fig. 1. North and south section, from Camp Creek Bore to Narrabeen Bore, across the Sydney Basin.

Fig. 2. North-east and east section, from the Liverpool Bore to the second Cremorne Bore.

Scale—Horizontal, 4 miles to 1 inch; vertical, 800 feet to 1 inch.

Plate reduced to two-thirds of the above scale.

PLATE II.

Plan showing position of Bores in the Sydney District.

Scale—4 miles to 1 inch.

NEWINGTON BORE
SYDNEY
ROSE BAY BORE

PLATE III.

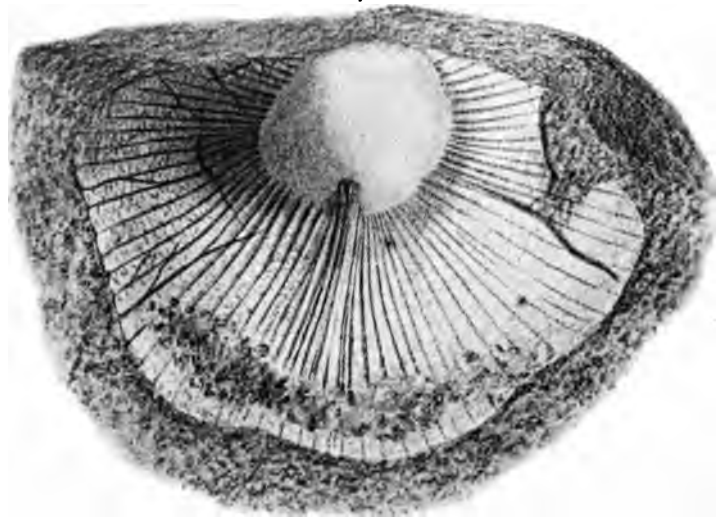
Mucophyllum crateroides, *Eth. fil.*

Fig. 1. The corallum seen from the truncated base, exhibiting the costæ, fimbriated edge, &c.

Fig. 2. The calice, showing the septa, fossula, and bare central tabulate area.

Drawn from nature by Mr. P. T. Hammond.

1



2

P.T. Hammond, del.

Heliotype.

PLATE IV.

Mucophyllum crateroides, *Eth. fil.*

Fig. 1. The corallum seen from the base, with remains of the radiciform processes.

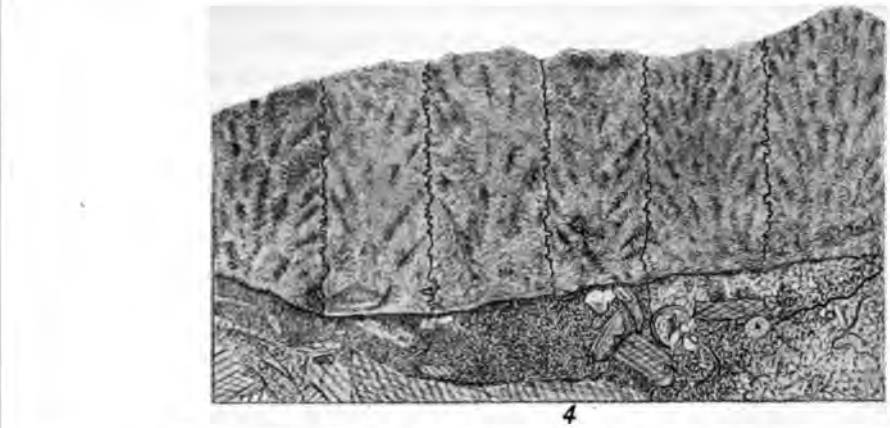
Fig. 2. The calice partially filled with matrix.

Fig. 3. Section of a small corallum, displaying thickness of the walls and tabulæ.

Fig. 4. Horizontal section, showing five simple fluctuating septa—x $7\frac{1}{2}$.

Fig. 5. Vertical section of a portion of the corallum with one of the hollow radiciform processes, tabulate—x $7\frac{1}{2}$.

Drawn from nature by Mr. P. T. Hammond.



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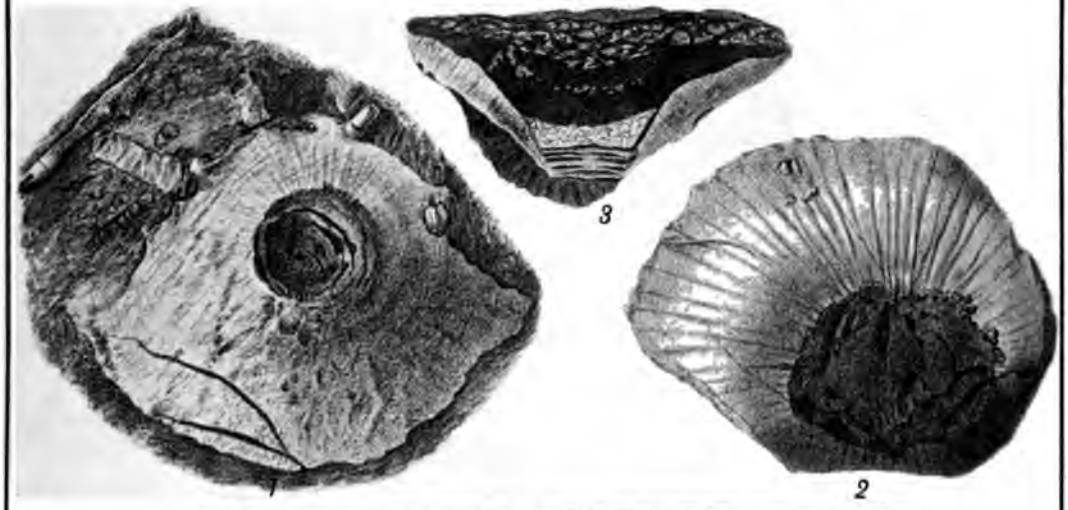

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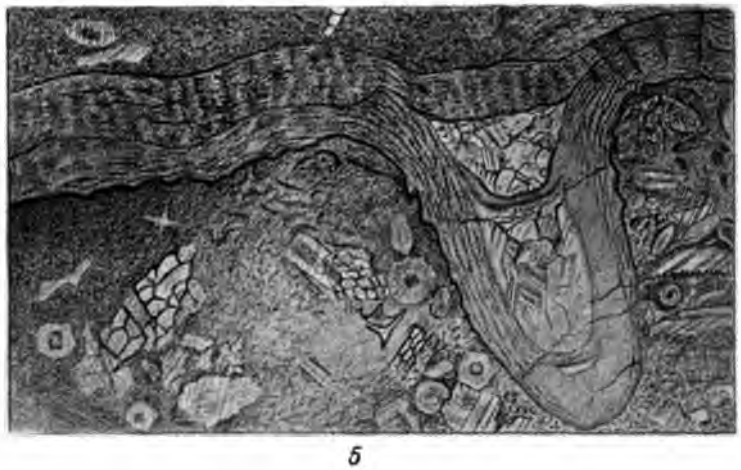


5

P. T. Hammond, del. Heliotype

PLATE V.

Diprotodon, *sp.*

Fig. 1. Third cervical vertebra, anterior aspect.

Fig. 2. Do do posterior aspect.

Drawn from nature by Mr. P. T. Hammond, one-half natural size.

1

2

P.T. Hammond, del.

Heliotype.

PLATE VI.

Pteronites Pittmani, *Eth. fil.*

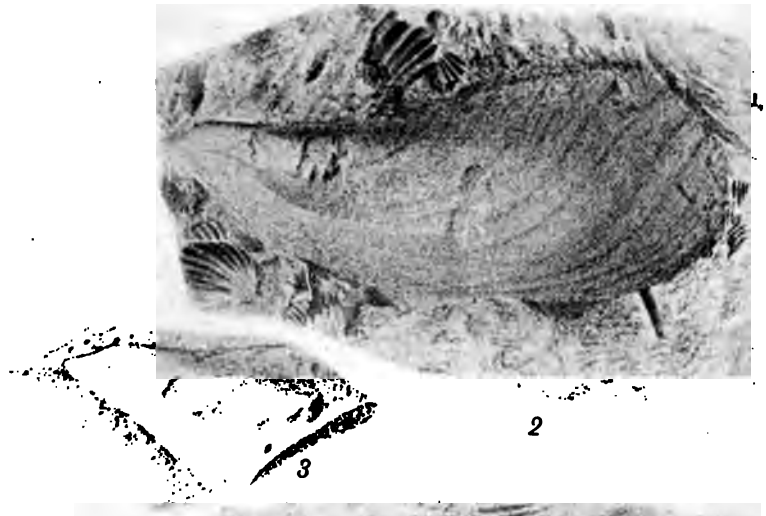
Fig. 1. Two individuals of medium size.

Fig. 2. A specimen that has attained maximum growth.

Fig. 3. Anterior end of a smaller example.

The drawings all represent left valves, and show the acute anterior ends, the concentric laminæ, and intermediate fine striæ.

Drawn from nature by Mr. P. T. Hammond.



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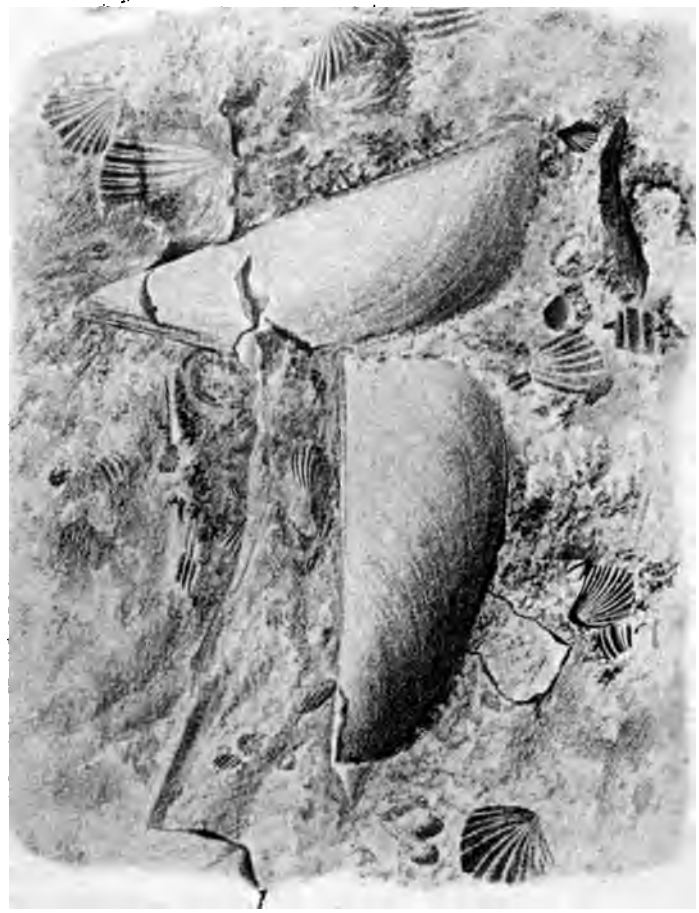


P. T. Hammond, del.

Heliotype.

PLATE VII.

Schizoneura (?) *sp.*

Fig. 1. Cross section of a stem and portions of three leaves.

Sagenopteris salisburoides, *Johnston* ?

Fig. 2. Leaf or pinnule with partly scalloped, partly broken margin.

Fig. 3. An entire pinnule attached to a stem, with smaller pinnules above.

Spirifera duodecimcostatus, *McCoy.*

Fig. 4. View of the dorsal valve, and ventral umbo.

Fig. 5. View of conjoined valves, area, and fissure.

Fig. 6. Surface sculpture magnified.

Fig. 7. Sculpture of the epidermal layer, natural size.

Fig. 8. The same more highly magnified.

Goniatites (Prolecanites ?) micromphalus, *Morris.*

Fig. 9. Side view of a full grown individual.

Fig. 10. Similar view of a smaller specimen showing the umbilicus.

Fig. 11. The same seen from the back, or ventral side, showing the slightly emarginated lips, and the oval scar above the penultimate growth stage.

Fig. 12. The lobes and saddles.

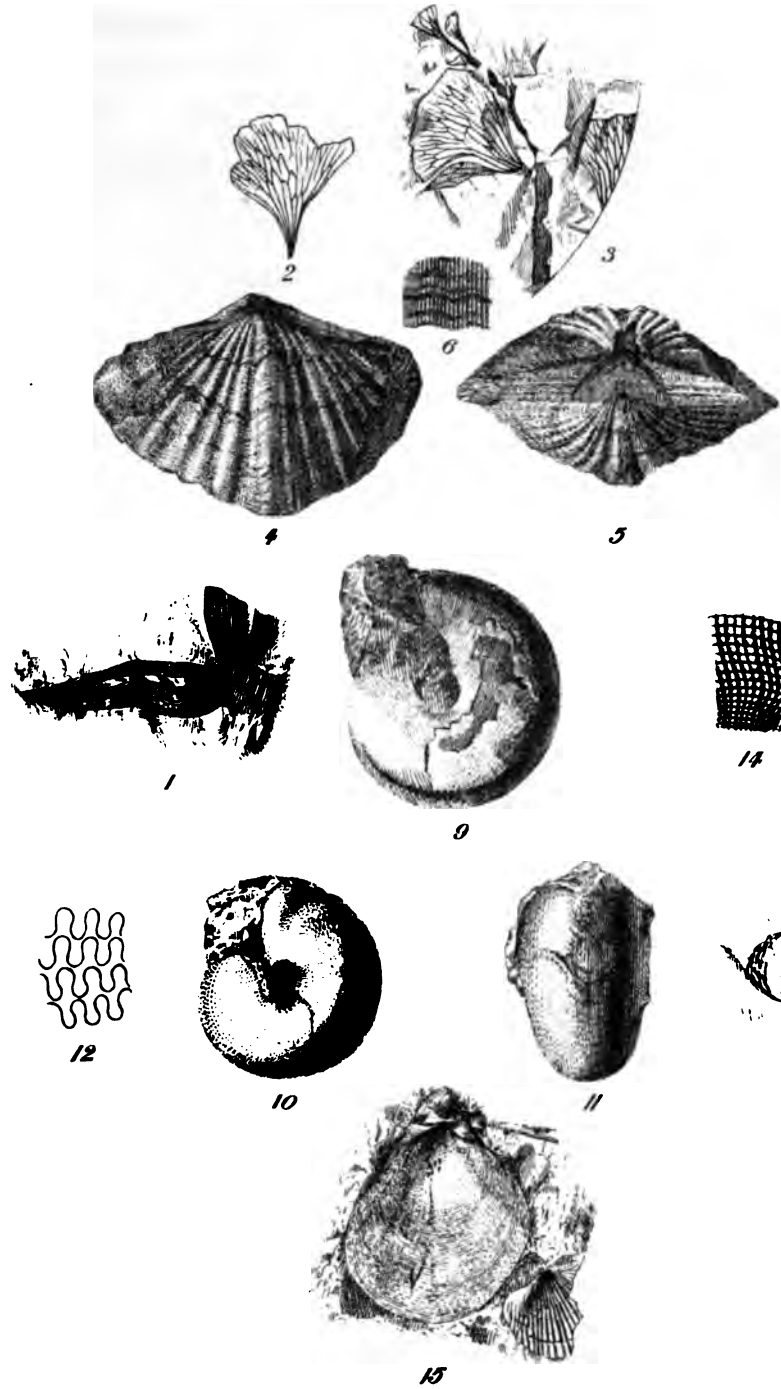
Fig. 13. The oval scar on the back or ventral side.

Fig. 14. The sculpture magnified.

Entolium, *sp.*

Fig. 15. Valve, probably the left, seen from the interior.

Drawn from nature by Mr. P. T. Hammond.



P.T. Hammond del.

(11.66-94.)

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DEPARTMENT OF MINES AND AGRICULTURE, SYDNEY.

RECORDS

OF THE

GEOLOGICAL SURVEY OF NEW SOUTH WALES.

Vol. IV.] 1894. [Part II.

XI.—On certain Coal and Shale Lands in the Capertee Valley District, embraced within the Parishes of Ben Bullen, Coco, Airley, Morundurey, Umbiella, Goongal, and Clandulla, in the County of Roxburgh, and Marangaroo, in the County of Cook, New South Wales: by Joseph E. Carne, F.G.S. Geological Surveyor.

I.—Physical Geography.

The country examined embraces the well-known features of the Blue Mountain scenery—high precipitous escarpments of sandstone with sloping flanks of clay shales, walling in valleys, some narrow and confined, others opening out into large amphitheatres, such as the Capertee Valley. In these denuded low-lying areas, isolated outliers of the sandstones and shales—such as Genowlan, Airley, and Crown Mountains—stand out like islands.

The Capertee Valley is drained by the Capertee River and its tributaries, Coco and Umbiella Creeks, and minor channels. The flow is eastward into the Hawkesbury River, and it is along the course of the former river that the Colo Valley railway trial survey has been run to avoid the ascent of the Blue Mountains.

The general fall of the country is to the north-east.

II.—General Geology.

Devonian.—The basal rocks exposed in the area in question consist of quartzites, slates, sandstones, and limestones of Devonian age. The quartzites and sandstones vary in texture from fine to coarse grain, and are fossiliferous in bands which are recognisable by the gossany fretted appearance of the outcrop, resulting, probably, from the precipitation of the iron oxide by the organic matter, and subsequent removal of the lime covering of the marine mollusca, the remains of which are abundant.

The only trace of a fossil flora discovered in these rocks, in the limited time available for search, was an indeterminable cast of a small stem.

The slates, particularly near the limestones, have a schistose character, and are nearly vertical. No traces of organic remains were found in them so far as examined.

The limestone occurs interbedded in the slates and quartzites. The main bed strikes—with the former rocks—across the valley in a N.N.W. direction. Rising in a high precipitous bluff near Mount Stewart, on the eastern boundary of the Parish of Goollooenboin, Co. Cook, it passes close to Crown Mount on the north-east side, thence through the north-eastern corner of the Parish of Coco, County Roxburgh, and under the Morundurey and Genowlan Mountains, making again at the surface in the Parish of Clandulla, on the north-west. The maximum thickness of the bed is about two-thirds of a mile. The total width of the exposure of Devonian rocks is about three miles.

In addition to the main belt of limestone numerous narrow beds occur at intervals in the quartzites and slates.

The quartzites and slates contain numerous small quartz veins, and it is probable that it was from this source that the gold was originally derived which was worked some years ago in the small patch of alluvial in Nuggety Gully, near the north-east corner of the Parish of Coco, or possibly from the degradation of a granite intrusion in the Devonian rocks, as in the case near Rydal described by the late Mr. C. S. Wilkinson*; but in either case the occurrence of gold in Nuggety Gully is not likely to extend beyond the small patch alluded to.

Near the limestone belt between the ten and twelve mile marked trees on the road between Capertee and Glen Alice, a narrow gossan leader occurs which is said to have yielded a small quantity of gold and silver.

The Devonian sedimentary rocks crop out also in Gallagher's Creek, about two and a half miles from Capertee, on the Glen Alice Road, and again near Airley Turret, both localities in the Parish of Coco. In the Parish of Clandulla, west of Portion 70, on the line of strike of the main belt in Goollooenboin, Devonian slates crop out in a small creek falling into Main Swamp.

* Min. Prod., N. S. Wales, 2nd Ed., 1887, p. 92.

Permo-Carboniferous (*Upper Marine Group.*)—Resting unconformably upon the upturned edges of the Devonian strata are beds of mudstones and shales filled with large boulders and pebbles of the underlying quartzites, and occasionally of granite. The base of these beds is coarsely conglomeratic, and is especially characterized by the size of the quartzite erratics. The upper beds are mudstones with more sparsely distributed rounded boulders and pebbles, and fine shaly sandstones, which present a marked concretionary structure in places. The top bed of the series consists of a thin bed of clay shale. The thickness of the Upper Marine beds in the Capertee Valley ranges from three hundred to five hundred feet.

Excellent sections, showing an unconformable junction with the underlying Devonian rocks, occur in the range just north of Mount Stewart, in the Parish of Goollooenboin, and in a creek falling into Main Swamp, between Portion 70 and the "Gap" in the Main Dividing Range in the Parish of Clandulla.

The Upper Marine beds form the surface over most of the low-lying land in the Capertee Valley.

Fresh Water Coal-Measures.—The base of the Fresh-water Coal Measures in the Western Coal-field has been fixed by Prof. T. W. E. David at the level of, and including a bed of coarse gritty conglomerate, named by him "Marangaroo Conglomerate," because of its development in the vicinity of Marangaroo. This bed appears to be chiefly developed along the south-western margin of the Coal Measures between Lithgow and Capertee. It forms a marked escarpment along the southern fall into the Capertee Valley. Where it appears as the surface rock, the ground is covered with rounded white quartz-pebbles. The arenaceous and quartz-pebbly character of this conglomerate readily distinguishes it from the mudstone and quartzitic boulders and pebbles of the Upper Marine Group upon which it rests conformably.

Above this conglomerate are the shales and fine-grained sandstone beds which form the actual coal-bearing horizon of the Permo-Carboniferous formation in the Western Coal-field.

The shales are marked in places by conspicuous cherty bands, and thin layers of ironstone—the so-called "clay band" ore of the above coal-field. The iron-ore has a peculiar concretionary and prismatic structure, no doubt due to the infiltration of iron salts into joints and shrinkage cracks resulting in a thin shell of ferric oxide enclosing a clayey kernel.

The shales are highly fossiliferous, the characteristic forms of the Australian Permo-Carboniferous flora, *Glossopteris*, *Vertebraria*, and *Phyllotheca*—being present in great abundance.

The coal-bearing beds of this region are believed to be identical with the Newcastle division of the Permo-Carboniferous Formation. They are confined to the elevated areas forming the table-lands, ranges, and isolated mountains; and their

highest limit is clearly defined by the commencement of the slope into the valleys directly beneath the precipitous sandstone escarpment. Their lower termination in the valleys, or rather on the slopes, is generally well marked by the absence of a loose shaley material, and the beginning of the characteristic yellowish clayey soil, with loose boulders and pebbles, formed from the weathering of the underlying Upper Marine beds.

The following section of the coal seams in the Lithgow Valley Coal-field, measured by Mr. J. Mackenzie, F.G.S., Examiner of Coal-fields, in the Lithgow Valley Coal Shaft, will serve as a guide to the area under description, as the coal seams in question extend into it in the same relative positions, but with varying thicknesses:—

ft.	in.	
10	0	Alluvium.
20	0	Sandstone.
4	0	Coal.
20	0	Sandstone.
13	6	Coal with a number of clay bands.
159	0	Shales, sandstones, &c.
1	0	Coal.
7	6	Shale and fireclay.
5	0	Fireclay.
1	0	Coal.
37	6	Friable shale with ironstone bands.
32	4	Sandstone and shale.
0	7	Coal.
4	0	Indurated clay full of *Vertebraria*.
10	0	Grey sandstone and conglomerate with coal pipes.
10	6	Coal with bands (Lower Lithgow seam).

The lowest coal seam—which is given in detail in Mr. Mackenzie's section—is the one worked in the Lithgow Valley Collieries.

As stated above, these seams extend into the area in question, and will doubtless have a value there in the future which they do not now possess. The special importance attaching to these seams at the present time is the occurrence in them of numerous and wide spread patches of petroleum oil cannel coal (Kerosene Shale). Though the known deposits in and near the Capertee Valley are of a lower average quality than those of Hartley and Joadja, yet in view of the anticipated early exhaustion of the latter, they must ere long come into prominence. It is indeed probable that the chief supply of shale will in the future be drawn from this and neighbouring localities to the north and east.

The principal shale mine, and the only one as yet from which the product is being sent to market, is the Genowlan Shale Company's, in the Parish of Airley, about seven miles north of Capertee Railway Station. The following section of the seam in the working tunnel was measured by Mr. E. F. Pittman, Government Geologist, &c.:—

ft.	in.	
1	8	First quality kerosene shale.
0	3	Splint coal.
0	5	Second quality kerosene shale.
0	6	Inferior bottom shale (discarded).
0	6	Fine-grained sandstone.
0	2	Ironstone band (carbonate of iron).
0	4	Bituminous coal.

The seam has an excellent roof and floor, and is worked by undercutting in the six-inch sandstone band, which yields readily to the pick. The shale, being very jointed, is easily broken down without explosives.

The six-inch bottom shale is at present discarded because of its inferiority as compared with the upper portion of the seam.

In the adjoining lease on the north, Foster and Party are driving a tunnel in the same seam.

The gap, through which the Genowlan Company's road passes to the surveyed Glen Alice and Capertee Road, divides the elevated coal-bearing tract in the Parish of Airley from a similar but larger area in the adjoining Parish of Morundurey. The northernmost extension of the latter is known as Genowlan, and the easternmost as Morundurey Mountain. The mineral leases in force cover the whole of the productive measures in both parishes. Across the gully from the Genowlan Company's tunnel the shale seam is stated to have been traced into the Genowlan Mountain; but prospecting operations are not at present being carried on.

In an ascent of the range forming the eastern boundary of the Parish of Gollooenboin, County Cook, and near Mount Stewart, on a line bearing about south-south-east from Genowlan Mountain, the perished outcrops of three coal seams were noted, one of which carried undoubted decomposing shale. From barometric measurement the latter corresponds with the Genowlan Company's seam. No prospecting has been done at this point.

The next most important deposit is in Corbett's Lease, M.L. 20, Parish of Gindantherie, County Cook. The seam occurs on the south side of the narrow gorge—locally known as "The Gully"—through which the Capertee River flows east of Glen Alice, at about twenty-three miles from Capertee Railway Station.

A tunnel has been driven into the seam for about eighty feet, but, for some unaccountable reason, not at right angles to the outcrop. The shale for the first half at least of the distance averages two feet in thickness without bands, but it has thinned at the faces to about one foot three inches. The following is the analysis of a sample selected by myself:—

Hygroscopic moisture	00·65
Volatile hydrocarbons, &c.	68·40
Fixed carbon	11·50
Ash	19·45
	100·00

Specific gravity	1·168
Sulphur	1·304 %

In the same parish the shale has been proved by Mr. I. Wall about three and a quarter miles to the south-east on the northern fall into the Wolgan River, north of Portion 25, in the Parish of Barton, County Cook. It has also been proved about four and a half miles to the south-west by Mr. C. Knoblanche, south of Portion 9, in the Parish of Gindantherie.

The occurrence of Kerosene Shale in the localities mentioned, viz., Corbett's Lease, Messrs. Wall and Knoblanche's discoveries, and near Mount Stewart—previously described—practically proves its persistence under the whole of the table-land in the Parish of Gindantherie, between the Capertee and Wolgan Rivers, though with what degree of uniformity of grade prospecting alone can show. In view of the above provings, the whole of the land in the parish mentioned has been recommended as a mining reserve. It may perhaps be added that it is practically worthless for any other purpose.

The Wondo Shale Mine, situated about one mile from Glen Alice Homestead, on the north-west, at the end of a high range trending west, is at present being re-opened under the management of Mr. Inch. Trial shipments are being obtained from an old tunnel in the east end of the range. The following is a section measured at the face of the working :—

2 in. Clay.
8 in. First quality shale (see analysis).
8 in. Inferior splint.
6 in. Second quality shale.
2 in. Coal.

The top eight inches of shale is the only portion of the seam at present being prepared for shipment. The following analysis of a sample selected will reveal its quality, the low percentage of ash being remarkable for the shale of this district:—

Hygroscopic moisture	00·25
Volatile hydrocarbons, &c.	75·55
Fixed carbon	15·85
Ash	8·35
	100·00

Specific gravity	1·072
Sulphur	0·642 %

I was informed by Mr. Inch that an analysis showing 85 per cent. of volatile matter has been made from the seam. The extension of prospecting operations in the leases under Mr. Inch's management may reveal a thickening of the top band of shale, or an improvement in the lower portion of the seam; otherwise it is questionable whether such a thin marketable portion will pay to work, especially in view of the twenty three miles cartage by teams.

At Mount Marsden, in the Parish of Clandulla, near Bogie Station, a tunnel was driven some time since in what is known as Morrison's Old Lease (now Campbell's). About eleven feet nine inches of coal and bands are exposed, and judging from the lumps at the tunnel mouth a shale seam a few inches thick occurs in it; but from the weathering and soakage in the sides of the tunnel, I was not able to distinguish it from the coaly material. An analysis of a sample selected from the surface heap gave the following results :—

Hygroscopic moisture	2·55
Volatile hydrocarbons, &c.	57·60
Fixed carbon	22·70
Ash	17·50
	100·00

Specific gravity	1·239
Sulphur	0·686 %

A section of the entire seam exposed in the tunnel was measured approximately, as follows:—

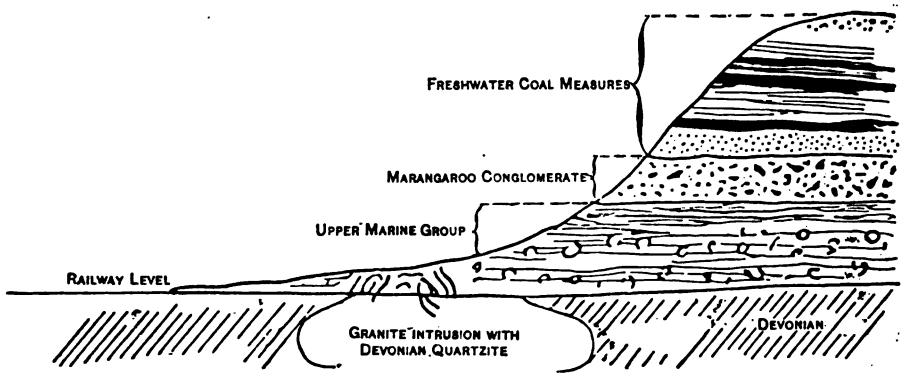
ft.	in.	
1	3	Coal.
0	1½	Band.
1	0	Coal.
1	0	Band.
2	0	Coal.
0	3	Band.
2	0	Coal.
0	1½	Band.
4	0	Coal (to floor of tunnel).

On the eastern slope of the main dividing range near "The Gap," due west of Mount Marsden, loose fragments of shale were found, though the seam was not discovered *in situ* owing to the heavy covering of alluvial and *débris*, and the absence of any extensive drainage erosion. The perished outcrops of two small coal-seams were, however, noted.

Though, as before stated, no description was contemplated of any of the land under examination embraced by the Geological Map of Hartley, Bowenfells, Wallerawang, and Rydal, yet in view of the subsequent prospecting of the shale seams at Marangaroo noted thereon, it will perhaps be advisable to add the results of a recent examination made in connection with Mr. E. F. Pittman.

The coal and shale seams occur just north of the Marangaroo Railway Tunnel, and have been prospected to a considerable extent by trenching on the outcrop of the lowest seams, and by two tunnels in the upper seams on the east face of ridge and one on the west, though work is not at present being continued.

The following sketch section showing the sequence of strata from the commencement of the Marangaroo Tunnel on the east side of the ridge may prove of interest:—



The main tunnel in the upper shale-bearing seam exposes the following section, measured by Mr. E. F. Pittman :—

Sandstone roof.

ft.	in.	
0	7	Coal.
0	2	Inferior shale.
0	6	Coaly-shale.
0	5	Second class shale.
0	9	Inferior shale.
1	5	Coaly-shale.
0	3	Second class shale.
0	4	Clay-shale.
1	0	Coaly-shale and bands.

A second section in a tunnel near by was measured with the following result:—

ft.	in.	
0	9	Dirty coal.
0	5	Inferior shale.
0	5½	Dirty coal.
0	1	Clay band.
1	2	Coal and bands.
0	10	Inferior shale.

About five feet above the main tunnel a small opening has been made in the top coal seam exposed in the ridge.

The most recent prospecting is a tunnel on the western fall of the ridge, exposing a seam giving the accompanying measurements :—

ft.	in.	
1	0	Bands of shale and shale bands.
0	3	Clay band.
1	7	to 2 ft. Kerosene shale—inferior—(No. 1 sample).
0	0½	Clay band.
1	0	Kerosene shale—inferior—(No. 2 sample).

The analyses of the samples selected from the two bands of shale are very disappointing as will be seen from the results here given :—

	No. 1 sample.	No. 2 sample.
Hygroscopic moisture	2·74	2·03
Volatile hydrocarbons, etc	36·64	28·84
Fixed carbon	8·28	10·89
Ash	52·34	58·24
	100·00	100·00

In connection with the occurrence of petroleum oil cannel coal, or kerosene shale, there appears to be a prevailing opinion amongst the miners engaged in working it, that a seam will pinch under a heavy covering ; in other words, when the workings extend beyond the sloping country on the side of a valley into and beneath the high sandstone cap of the mountain, ridge, or tableland, the shale will

thin out. However much past workings may appear to support this view, there can be no real ground for such a belief, inasmuch as the one time extension of the heavy sandstone covering over all the intervening valleys, must be apparent to even the most casual observer of the corresponding features presented by similar horizons in opposite mountain faces. The present surface configuration being due to denudation long subsequent to the deposition of the strata containing the shale and the material forming it, the comparatively recent removal of a portion of the overburden could have had no conceivable effect upon the thickness of the seam.

Hawkesbury Series.—The sandstone beds which form the summits of the elevated areas in the Capertee Valley District, and which present vertical cliff faces to the valleys, are the lowest beds of the Hawkesbury (Triassic) Series, and should, perhaps be termed "Narrabeen" beds, in strict accordance with the latest division of the series into—

Hawkesbury Series	Wianamatta Shales.
	Hawkesbury Sandstone.
	Narrabeen beds.

Probably a detailed examination may reveal thin cappings of the Hawkesbury Sandstone proper on points of extreme elevation.

The Narrabeen beds are characteristically developed at Narrabeen, near Manly, from which they derive their name. Here the beds are of considerable thickness, though probably thinner than at Cremorne Point, Port Jackson, where a thickness of 1896 feet 6 inches is recorded in the diamond drill bore recently put down.*

The Narrabeen rocks at Cremorne consist chiefly of chocolate shales with greenish-grey and white sandstones and beds of tuffaceous material, but in the Western Coal-field beyond Lithgow the arenaceous beds predominate almost to the exclusion of the argillaceous.

Eruptive Rocks.—In only one instance was an eruptive rock, of more recent date than the Freshwater Coal Measures, observed in the area examined.

In the railway cuttings south of Ben Bullen, between the 119 and 191¾ mile pegs, granite is seen forcing up with it on either side rocks of Devonian age—the latter showing considerable alteration by the contact. For some distance the marine beds are filled with large boulders and fragments of the granite.

In the road cutting in the Genowlan Gap an apparently small basaltic dyke is revealed, and rendered noticeable by the porcellanised condition and prismatic form imparted to the clay shales on the line of contact. The occurrence of basalt on the top of Airley and Genowlan Mountains has been recorded by Mr. Mining Surveyor Seaver in his report on Kerosene Shale at Capertee.†

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* *Vide* Notes on the Cremorne Bore, by Prof. T. W. E. David, B.A., F.G.S., and Mr. E. F. Pittman, A.R.S.M.—*Journ. R. Soc. N. S. Wales for* 1893 [1894], XXVII, p. 443.

† Ann. Rept. Dept. Mines N. S. Wales for 1883 [1884], p. 28.

III.—Palæontology.

Devonian (*Marine*).—Mr. R. Etheridge, Junr., Palæontologist to the Geological Survey, has identified the following forms amongst the fossils collected in the Devonian rocks about three hundred yards south-east of D. M. M'Lean's Homestead on Portion 60, Parish Goollooenboin, County Cook:

Spirifera disjuncta, *J. de C. Sby.*
Nuculana sp. (of a Carboniferous facies).
Bivalves (too indistinct for determination).

From the Limestone Bluff, known as "Blue Rock," near Mt. Stewart, in the same parish:—

Syringopora, 2 sps.
Stromatopora.
Amphipora.
Athyris.

Permo-Carboniferous (*Upper Marine Group*).—From about thirty chains west of the north-west corner of Portion 80, Parish Goollooenboin.

Martiniopsis subradiata, *G. B. Sby.*
Spirifera vespertilio, *G. B. Sby.*
Goniatites or Bellerophon.
Fenestella.
Mæonia (small species).
Small bivalves (difficult of determination).

The occurrence of Upper Marine fossils *in situ* was noted in Portion 71 of the same parish, on the road to Glen Alice.

The following note by the Palæontologist is worthy of attention:—"A very interesting fact is foreshadowed by this small collection. At M'Lean's Homestead *Spirifera disjuncta* occurs in a decomposed rock. In New South Wales this species is confined, so far as we know, to the Upper Devonian, but in Victoria occurs in the Middle Devonian (Buchan Limestone). It is but reasonable, therefore, to regard the M'Lean Homestead beds as referable to one of these two horizons. Interbedded with this deposit, Mr. Carne states, is the blue limestone containing corals, akin, although I do not at present say identical, with species occurring in the thick Cave Limestones. If we provisionally retain these beds as Upper Devonian, from the known range of *Spirifera disjuncta* with us, we have presented the interesting fact of the occurrence of coral limestone in them, a point that I, for one, was not previously acquainted with. Good results would probably be obtained by a further search at these places."

XII.—On the Occurrence of an *Oleandridium* in the Hawkesbury Sandstone Series: by R. ETHERIDGE, Junr., Palæontologist and Librarian.

[Plate VIII]

I.—Introduction.

THE present addition to the Hawkesbury Sandstone Flora is known from two localities, occurring at both under similar geological conditions. The leaves, about to be described, are provisionally referred to *Oleandridium*, Schimper, from their shape and distinctly petiolate nature, for the fructification, on which Schimper appears to have chiefly diagnosed his genus, has not been observed.

The first specimens were collected by Mr. C. Cullen, Collector to the Geological Survey of New South Wales, at the Railway Ballast Quarry, Gosford, the locality that has yielded fish remains so plentifully, described by Mr. A. S. Woodward. The leaves were next obtained by Mr. B. Dunstan at Freshwater, near Manly, and he has been kind enough to present specimens to the Departmental Collection. In both instances the leaves occur in a bed of shale, intercalated in the Hawkesbury Sandstone, certainly in one case, and probably so in the other.

II.—Specific Description.

OLEANDRIDIUM LENTRICULIFORME, *sp. nov.*

Pl. VIII, Figs. 1–3.

Sp. Char.—Leaves simple, elongately lanceolate, or boat-shaped, broad in the centre, attenuating both towards the apex and base, petiolate, and apparently more or less coriaceous; apex obtuse to a variable degree, but never acute; petiole long and strong; margins entire, and not waved, gently curved from base to apex; midrib broad and strong near the base, rapidly decreasing upwards to a fine vein; secondary veins rather variable in number in a given space, but generally about three in the space of one millimetre, issuing from the midrib at an oblique angle, but without any change in the direction of their course; seldom dichotomous, but when so once only, and then near the midrib.

Obs.—The only variability I have noticed consists in that of the width of the leaf, as compared with its length, and in the degree of obtuseness of the apex. As regards the first point extremes may be seen in Pl. VIII, Figs. 1–3; and as to the second Figs. 1 and 3 afford a good illustration, for the apex of Fig. 2 is incomplete, and would, if perfect, be narrower, and not so rounded. The largest specimen seen (Pl. VIII, Fig. 1) is five and three-quarter inches long, by one inch wide at the centre of the leaf. The smallest perfect leaf observed (Pl. VIII, Fig. 3) is three inches long by half an inch wide.

The lanceolate or almost boat-shaped form is a very characteristic feature, and seems to vary but little amongst a large number of specimens, the more club-shaped outline of Fig. 2 arising from a cause before explained. The margins are always entire, and never waved. The petiole is also another important feature in *O. lentriculiforme*, its length assisting to impart the peculiarly graceful outline characteristic of these leaves. In one instance (Pl. VIII, Fig. 2) the petiole amounts to one-third the entire length of the leaf. The midrib, although gradually tapering to the apex as a very thin vein, is quite persistent. The nervation appears to be characteristic of the species, especially as regards another plant to be noticed hereafter. The secondary veins do not issue from the midrib at an acute angle and then break off into the horizontal, but on the contrary, they leave the midrib at an acute angle and continue in the same direction to the margins. Few of them appear to be furcate, but when so dichotomy appears here and there at irregular intervals. The bifurcation may take place near the midrib, it usually does so in fact, but instances have been noticed where it occurs near the centre of each wing of the leaf. So far as observation has gone the bifurcation is unifurcate in respective veins.

We may now compare the leaves of *O. lentriculiforme* with those of some of its allies.

Oleandridium vittatum, Brong., sp.,* possesses a much longer and more slender leaf, with a widely separated secondary neuration. The latter agrees, however, with the veins in the present form, in being sparsely furcate. Feistmantel's figures† of *O. vittatum* illustrate the long very broadly strap-shaped outline of its leaf even better than Brongniart's, and also the irregularity of the furcation. Another European species, *O. tenuinerve*, Brauns, sp.,‡ bears a general resemblance to the Australian, but is less ovoid, and much more lingual. Nathorst's Swedish figures§ of this plant exhibit an equally long, but more slender petiole. Another Swedish species, *O. obtusum*, Nathorst,‖ is distinguished by its regularly strap-shaped outline, with an emarginate obtuse apex. Were it not for the very fine lengthened petiole this would almost fall into the genus *Angiopteridium*. An equally narrow strap-shaped form is *O. Beyrichii*, Schenk,¶ also with an obtuse and emarginate apex, thus differing from our plant in precisely the same characters as *O. obtusum*.

The nearest ally of *O. lentriculiforme* with which I am acquainted is *O. stenoneuron*, Schenk.** Unfortunately Schenk's illustration is that of an imperfect leaf, but so far as its characters can be made out it appears to be a close ally of our plant.

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* Hist. Foss. Veg., 1828, I, p. 263, t. 82, f. 1–4.
† Pal. Indica (Gondwana Flora), 1876, II, Pt. 1, p. 15, t. 1, 2, and 12.
‡ Schenk's Foss. Flora Grensch., 1868, Atlas, t. 25, f. 3 and 4.
§ Floran vid Bjuf., 1878, I, Pt. 1, t. 7, f. 6.
‖ *Ibid*, t. 8, f. 7, 9, 10, 13.
¶ Beiträge Flora Vorwelt, Heft 4, t. 8, f. 6–7*a*.
** Foss. Flora Grensch., 1868, Atlas, t. 25, f. 5 and 6.

The outline and neuration of *O. lentriculiforme* will serve to distinguish it from the Australian *Tæniopteris Carruthersi*, Ten. Woods,* but until the base of the latter is known, to say nothing of its fructification, it will be impossible to place it correctly in its genus. Notwithstanding that numerous figures of the leaves of this plant have been published by Feistmantel and others, no complete illustration has appeared, so far as I know; nor am I acquainted with a perfect example in collections. It is always represented as a broad-linear, more or less parallel-sided, long, *Angiopteridium*-like leaf, with the secondary veins constantly furcate near the mid-rib, arising from the latter at a very acute angle, and then directed outwards towards the margin, at an oblique, although less acute angle. These veins are seldom horizontal, as stated both by Tenison Woods and O. Feistmantel. This fact is apparent both in the original figure of Mr. Carruthers and in Dr. Feistmantel's. Under these circumstances I can but regard the two Australian plants as distinct.

Loc. and Horizon.—The specimens obtained by Mr. Cullen are from a bed of shale in the Railway Ballast Quarry near the Gosford Station on the Northern Railway. The fossiliferous shale lies near the base of the section as then exposed, but at the top of a group of flaggy hard sandstones. The section revealed by the neighbouring Ourimbah bore "renders it doubtful whether the bed belongs to the lower portion of the Hawkesbury Sandstone or to the upper portion of the Narrabeen Shales,"† conformable members of our Triassic System.

Mr. Dunstan's examples of *O. lentriculiforme* were obtained in shale and shaly-sandstone at Freshwater, about one mile and a quarter miles north of Manly, "being the second point on the coast-line north of Manly Ocean Beach."‡ This horizon is in the Hawkesbury Sandstone.

XIII.—Notes on the Occurrence of Diamonds at Bingera (Bingara): by G. A. STONIER, F.G.S., Geological Surveyor.

A REPORT of the discovery of a supposed volcanic pipe on the Melbourne and Bingera Diamond Mining Company's property has recently afforded an opportunity for an examination of the latest developments in some of the Bingera deposits. The latter have been known for a number of years to be diamantiferous, and have been reported upon officially by—

(1.) E. F. Pittman, Ann. Rept. Dept. Mines N. S. Wales for 1881 (1882), p. 141.

* Proc. Linn. Soc. N. S. Wales, 1883, VIII, p. 117.
† David, Mem. Geol. Survey N. S. Wales, Pal. Series, No. 4, 1890, p. viii.
‡ Dunstan, Journ. R. Soc. N. S. Wales for 1893 [1894], XXVII, p. 378.

(2.) C. S. Wilkinson, Ann. Rept. Dept. Mines N. S. Wales for 1886 (1887), p. 89.

(3.) W. Anderson, Ann. Rept. Dept. Mines N. S. Wales for 1887 (1888), p. 156.

These reports, as well as two on N. S. Wales diamonds* and Professor Liversidge's work,† have been freely used in the preparation of the following notes.

The deposits which have many characteristics in common with, but are, nevertheless, distinct from the Cope's Creek (Inverell, N.S.W.) drifts, are auriferous as well as diamantiferous, and are developed chiefly within an equilateral-triangular area of three square miles in the Parishes of Bingera and Derra Derra, County Murchison, about five miles west-south-west from the township of Bingera, and two hundred and eighty miles from Sydney in a direction a few degrees west of north. Bingera is situated on the Gwydir (or Big) River, which is a main stream in the north-western fall of the Colony, and flows in a north-westerly direction for six miles below the township, where it receives, as a tributary, the Horton (in the early days known as the Big) River, which latter branches off in a southerly direction. A well-marked range 1,200 to 1,400 feet above Bingera divides the waters of the streams above their junction; the water-parting is sharply defined in places, but near the diamond mines the range is flat-topped, having a width of nearly two miles, and breaking off precipitously on each side; the mines are situated on the north-eastern fall and close to the range, which, with a spur, encloses them somewhat in the form of a horse-shoe.

The deposits consist of gravels and sands of Tertiary age (with unimportant Pleistocene and Recent redistributions) now occurring chiefly, as far as has been proved, as outliers in ridgey country about five hundred feet above the main water-courses; for the most part they are loose and easily mined, but in places becoming compact with occasionally thin beds of a hard ferruginous quartz conglomerate; some are undoubtedly of fluviatile origin, but it is not clear that other portions are not littoral deposits. Several instances occur on the field where there appears to be neither outlet nor inlet for the drift—they may possibly represent deep waterholes in the old channels.

The pebbles contained in the gravels are waterworn, subangular, and angular, the majority being well rounded; they vary in size from a half to six inches, averaging about two inches with occasional boulders up to two feet in diameter, and are composed chiefly of a red jasperoid claystone, jasper, and black siliceous mudstone with quartz of various kinds, felspathic quartzite, pale greenish grey siliceous shale, altered claystone, and other altered sedimentary rocks, rarely a felspar porphyry, a variety of small gemstones and minerals and stiff whitish-grey clay boulders, the proportion of the different rocks varying in each separate deposit.

* Etheridge, Junr., and Davies, Ann. Rept. Dept. Mines N. S. Wales for 1887 [1888], p. 42. L. Atkinson. *Ibid.*, p. 46.

† Minerals of N. S. Wales, 1888, p. 235.

The drifts have a maximum thickness of sixty-five feet; they cannot, however, be averaged, nor can the average thickness of the diamond-bearing portion be ascertained until the deposits are more opened out. At Craddock's Claim (M.L. 126) it is proposed to work ten feet of the drift; at M.L. 139, fifteen feet is considered to be diamantiferous; and at the Monte Christo, where only two feet six inches was taken by the previous leaseholders, Captain Rogers has opened two drives, showing four, and from four to nine feet respectively of wash-dirt, from a shaft thirty-six feet deep in a portion of the ground previously untested. The diamantiferous wash, not including that which is covered by basalt and not yet tested, covers a superficial area of about two hundred acres, and although in the rich patches diamonds are plentiful and astonishing prospects can be obtained, it is exceptional for a large body of wash to contain an average of more than one to one and a half carats to the load, and much of the drift will not yield a carat to the load. In some of the claims the gems are fairly distributed, but in others they are confined to layers about nine inches thick, separated by a variable and inconstant amount of drift which is absolutely valueless. In one instance five of these layers occur in a face of seven feet of drift. The layers cannot be relied upon for even a few feet, but may cut out unexpectedly, and, when close to a sidling, have been found to rise with the bed-rock, until, instead of being horizontal, they have acquired a steep dip. The diamonds are found to be accompanied almost invariably by small fragmentary gemstones (sapphires, zircons, &c.) and well-worn "pencil" tourmalines; as a rule "morlops," small rounded siliceous pebbles with an exceptionally high degree of polish and composed of black siliceous mudstone and jasper of various colours, are also present.

The diamonds are small and average five to the carat (the average varies on different parts of the field from three to seven) running up to twenty to the carat, with not more than one per cent. of carat stones in a general parcel, and in some cases five per cent. of three-quarter carat and ten per cent. of half carat stones; the largest yet found was considered to be three and a-half carats, but actually weighed two and one-eighth carats—it was flawed and not of value. At Inverell larger stones are found than at Bingera; one was obtained which weighed seven and a-half carats.* As a rule more than fifty per cent. are straw-coloured, and of the diamonds exhibited at the Indian and Colonial Exhibition in 1886, thirty-three per cent. were colourless with one per cent. of "rejections." They are harder than the Cape gems and hence take longer to polish, but in brilliancy and refractive power the New South Wales stones surpass the African, and one cut in London in 1886 is stated to have been as fine a brilliant as it was possible to obtain from any part of the world. About one per cent. of the stones are found almost perfectly crystallised with flat facets, the remainder having curved, rounded, and fractured (eight per cent?) faces often pitted, and it would appear possible that

* C. S. Wilkinson, Ann. Rept. Dept. Mines N. S. Wales for 1887 (1888) p. 43.

a small percentage are travelled fragments of gems much larger than any yet found in the deposits themselves. Mr. R. Etheridge, Junr., states that the Inverell gems which he carefully examined in London were all crystallised and that none of the faces were abraded.

The gold on the western portion of the field is fine and flaky, with fine specks somewhat cubical in shape and sometimes coated with "rust," and occasionally quartz specimens; it is said to be worth £4 2s. per ounce. Well-worn pieces of six and seven dwts. occur in the eastern drifts, and have a value of £3 14s. per ounce. Payable gold has not been discovered in the drifts themselves; several recent re-distributions of the diamantiferous wash have paid wages in the past but are now worked out. Platinum (? Osmiridium) is also found, but not in sufficient quantity to encourage any attempt to save it.

The diamantiferous wash rests upon a series of sands, clays, and ironstones, with occasionally thin layers of wash; the formation is fossiliferous, and has yielded a small *Unio* allied to *Unio Wilkinsoni*, Eth. fil., the seeds *Plesiocapparis leptocelyphis* and *Phymatocaryon Mackayi*, F.v.M.,* and various leaves not yet determined. The clays, &c., occupy a large area, and have a maximum thickness of nearly four hundred feet, but as they were subjected to considerable denudation prior to the deposition of the diamantiferous wash, and the bed-rock also shows evidence of deep erosion, the thickness is very variable. To the south and west of the diamantiferous outliers, the clays are overlaid by basalt of which there are two distinct sheets separated by one hundred to a hundred and twenty feet of fine gem sand with thin beds of clay and gravel, which is said to have yielded several small diamonds. The lower basalt has a maximum thickness of three hundred feet averaging about one hundred and fifty feet, and varies in width from a few hundred yards to nearly two miles, extending in a north-westerly direction for nine miles; the upper sheet has a maximum thickness of three hundred and fifty feet, and has been denuded into large outliers. It is probable that the diamantiferous wash extends under the lower sheet of basalt, but independent of that wash and necessarily of an earlier geological age, a lead has been proved to exist between the clays and the bed-rock, and there is every reason to believe, from the occurrence of a high ridge forming probably one of the sidlings of an old channel, that it runs for a considerable distance. So far as can be ascertained the wash was perfectly barren where it was struck, but as the work is confined to two shafts, further prospecting operations are very necessary. In one of the shafts referred to a large body of wash was struck, consisting chiefly of pale greenish-grey laminated quartzite, altered mudstone, and siliceous sandstone, fairly well rounded and up to eight inches in diameter. The other shaft struck a thin layer of a fine well-worn quartz wash.

* R. Etheridge, Junr., Ann. Rept. Dept. Mines and Agric. N. S. Wales for 1891 [1892], p. 268.

The bed-rock contains *Lepidodendron australe*, McCoy, and various marine shells not yet examined; it consists of thin bedded mudstones, sandstones, and occasionally conglomerates, argillaceous and oolitic limestones and quartzites; hard, thick-bedded, in some places massive, gritty tuffaceous and calcareous mudstones and sandstones passing into volcanic tuffs, and breccias with interbedded porphyrite (?). They are traversed by a number of veins of quartz and calcite (in places auriferous), and a few felspathic, somewhat brecciated, lodes, and are intersected by dykes of diorite, and occasionally basalt (?), and masses of felspar-porphyry, and, to the east and south of the township of Bingera, by serpentine and a coarse ternary tourmaline granite. These rocks will be more fully described on completion of the microscopic slides.

The future of the diamond industry at Bingera depends largely upon the discovery of a matrix, and the exploitation of the basalt range. That the deposits in which the diamond occur are totally dissimilar to the Kimberley pipes there has never been the least reason to doubt, but the question as to whether the diamonds have not been derived from a formation which bears some resemblance to that of the Kimberley pipes is still unsettled. That the diamonds were formed in the drifts is held by several writers on the subject, and the late Mr. Norman Taylor* considered that at Cudgegong, in the Western District of N. S. Wales, where there are drifts of two ages, the diamonds were formed in the older and distributed into the more recent drift. The late Mr. C. S. Wilkinson held the same view at one time, but after an extended examination of the various diamond deposits in the Northern District he suggested that "if the Tertiary drifts be not the original matrix of the diamond, possibly its source may be in the metamorphosed Carboniferous or Devonian beds, where they have been intruded by granite and porphyry"†. Prof. T. W. E. David, whom the Author of this paper accompanied on a visit to the Cope's Creek diamond mines in 1891, came to the conclusion that the Cope's Creek (*i.e.*, Malacca, Round Mt., &c.) diamonds were probably derived from the tourmaline granite.

At Bingera there are two drifts, but the older drift has not been found up to the present time to contain diamonds, and it does not appear to be at all probable that the gems have been formed *in situ*; as, however, they are found in a pipe of picrite-porphyry (Stelzner) at Kimberley, and altered peridotites occur in New South Wales, why should not a pipe have been formed in this country also? The occurrence of a pipe mass on the diamond field at Mittagong, New South Wales, has been already noted by the late Mr. C. S. Wilkinson‡, and it would appear likely that prospecting operations will prove that this "pipe-dyke" mass contains diamonds. So far as my observations have extended, the volcanic breccias of the

* Geol. Mag., 1879, VI, p. 457.
† Ann. Rept. Dept. Mines N. S. Wales for 1887 [1888], p. 137.
‡ Ann. Rept. Dept. Mines N. S. Wales for 1890 [1891], p. 210.

Bingera district, already observed, belong to a series of contemporaneous submarine tuffs interbedded with sediments of probably Carboniferous age. Hitherto, so far as can be ascertained, no definite trace of volcanic breccias of later age have been observed in the district, although it is of course highly probable that rocks of that description may occur in the neighbourhood of the original sources from which the basalts covering the diamantiferous gravels flowed. It is obviously impossible, however, that the diamonds in the drifts could have been derived from any volcanic pipe of later age than the diamond-bearing gravels, and as the basalt is younger than the gravels, the diamonds must probably have been formed from plutonic action in some eruptive rock older than the basalts overlying the diamond drifts. Of these there are two varieties—

1. Serpentine.
2. Tourmaline granite.

That the serpentine (an altered peridotite) was formed earlier than the diamond drift, and therefore may have been the source of the diamonds, is rendered probable by the presence of numerous pebbles of red jasper in the diamantiferous gravels, the jaspers having been chiefly formed by the intrusion of the serpentine into the Carboniferous sedimentary rocks. This serpentine belt can be traced almost without a break from Attunga, near Tamworth, to within a few miles of Warialda, a distance of ninety miles; jaspers are found, sometimes in large masses, for nearly the whole distance at the junction of the serpentine with the sedimentary rocks.

That the tourmaline granite is older than the diamantiferous gravels is obvious from the amount of detrital material derived from it, and found in the diamantiferous gravels at Cope's Creek, near Inverell.

There are also possible sources in the Carboniferous tuffs—there can be no doubt that they are older than the gravels—and in basalts somewhat older than the diamantiferous gravels, but of the existence of such basalts no evidence has yet been obtained.

The question is by no means settled, and although there would appear to be no reason why one of the sources should not be found near Bingera, the recent work on M. Ls. 9, 47, and 134 (the property of the Melbourne and Bingera Diamond Mining Company) has failed to disclose it.

XIV.—The Idiographic Carvings at Cockle Creek, Cowan: by R. ETHERIDGE, Junr., Palæontologist and Librarian.

[Plate IX.]

I.—Introduction.

MY first acquaintance with these carvings arose from a brief note and sketch by Mr. R. Dalrymple Hay, of the Crown Lands Department, and Forest Ranger, published in the "Surveyor."* Mr. Hay was kind enough to conduct Mr. G. H. Barrow and myself to the locality.

These carvings are without doubt the most interesting that have yet come under my notice, for amongst them are portrayed the figures of the woman and the Emu, objects that played no insignificant part in the mythology of our east coast Blacks, as I hope to show in the sequel. Not only do these possess this important bearing, but even the posture of the male figures is suggestive of those assumed by the wizards in some of the ceremonial magic dances performed during the *Bora* ceremony.

II.—Locality.

The carvings occur on the rounded table of sandstone usually selected as an appropriate site at a place called Bobbin, close to which runs the old track. The sandstone table is immediately at the head of a gully running into the left-hand branch of the head waters of Cowan Creek, and known as Cockle Creek, in the Parish of Gordon, Co. Cumberland. The table runs nearly in a north and south direction, and is so much overgrown with scrub, like the whole of the surrounding area, that, could this be cleared away, no doubt additional figures would be exposed to view. The unfrequented and retired nature of the spot has probably contributed to the excellent state of preservation of most of the carvings, and rendered their delineation comparatively easy.

III.—The Figures.

As a rule carvings of this description are clustered together, but in the present instance this is departed from, and the figures occupy an extended line, following one another in tolerably rapid succession, in the order displayed on Mr. Hay's sketch. There were at least fifteen recognisable figures at the time of our visit, the following being the most important—an imposing male figure (Pl. IX, Fig. 15), with arms raised above the head, and the legs bowed, girt with the belt of manhood, and exhibiting not only the eyes—a very unusual addition to these carvings—but also a series of radiating lines from the crown of the head, and

* The Journal of the Inst. Surveyors N. S. Wales, 1892, V, No. 8, p. 198.

with the fingers correctly represented. The figure is in all six feet two inches in height, and both as to correctness of drawing and detail is a great advance on similar representations in previously recorded cases. Lying next to this, and with one leg thrust across the man's thigh, is the undoubted figure of a woman (Pl. IX Fig. 14), also with the arms extended upwards, and the legs, instead of being gathered up under the body, extended outwards. Here again nature has been faithfully copied in that the pendulous mammæ of the female aborigine are correctly represented. This is also the case in the figure of the second woman (Pl. IX, Fig. 5). In this instance the feet are wanting and only one hand is present, whilst in the former case (Pl. IX, Fig. 14) one foot is shown. What is, however, particularly interesting in this representation, is the peculiar heart-shaped body placed above, but unconnected with the head. The female figures are respectively three feet six inches high (Pl. IX, Fig. 14) and three feet five inches (Pl. IX, Fig. 5). An imperfect outline (Pl. IX, Fig. 2) is also intended for a human figure, with the arms outstretched, and a more or less bird-like head, a repetition of one of the outlines seen at Bantry Bay.

I can offer no solution of the two globular bodies resting on the shoulders of Fig. 2. In Pl. IX, Fig. 4, is seen a well formed leg two feet long, bent at an angle not infrequently seen in some of the dances practised by the Aborigines. Fig. 3 is again an extraordinary representation, and unless it be intended for a Flying-fox (*Pteropus*), I cannot offer any other explanation. It is three and a half feet high, and the terminal prolongations, or legs, are only punctured on the surface of the rock, as if the execution of the figure had been suspended before completion.

Next to the human figures, however, the most interesting and important are the large feet (Pl. IX, Fig. 13 *a* and *b*), of which there are three on the sandstone table. Those here copied are about one foot in length, and occupy between the fore extremity of the one, and the hinder point of the other, a space of seven feet, thus leaving five feet of a stride between them. Feet are occasionally seen in pictorial drawings met with in Cave-shelters, such for instance as those on Wollombi Creek figured by Mr. P. T. Hammond,* but this is the first instance I have met with amongst Idiographic Carvings.

Figs. 6 and 8 are representations of the Emu. The largest (Pl. IX, Fig. 6) is six feet long, and the other (Pl. IX, Fig. 8) is three feet ten inches. The attitudes are different, one standing erect, with the neck outstretched, the other bending down as if in the act of feeding. Near them is placed a smaller bird (Pl. IX, Fig. 7) of irregular proportions.

Amongst the remaining delineations is probably what is meant for an Opossum (Pl. IX, Fig. 10) nearly four and a half feet long, occupying a position, as near as possible, one foot from the male and female figures, contiguous to one another (Pl. IX, Figs. 14 and 15). The tail, however, is somewhat short for this animal. Eight

* Records Geol. Survey N. S. Wales, 1892, II, Pt. 4, t. 15.

feet beyond this lies a Flying-squirrel (*Petaurus*) about two feet four inches long (Pl. IX, Fig. 9), the lines no doubt being intended to portray the membranous expansion between the limbs, and the change in colour of the fur on these "wings." The next figure in order of interest is that of an Iguana (Pl. IX, Fig. 1), seven feet three inches in length.

The smallest object (Pl. IX, Fig. 12) is probably an *Echidna*, resembling that seen at Bantry Bay, Middle Harbour,* and is not far from the same size, both being about one foot six inches long.

The last figure to be noticed (Pl. IX, Fig. 11) is unquestionably a dilly-bag, or rather basket, three feet nine inches long, the nearly circular mouth and the lines representing the "staking" and "siding" of the basket work showing this.

Three very important points are to be noticed in the study of this group of carvings, viz., the entire absence of representations of (*a*) fish, (*b*) shields, and (*c*) the kangaroo, either one or the other, and sometimes all three, having been noticed at most of the other localities.

IV.—Possible Interpretation.

In entering on this debatable portion of the subject it may not be out of place to quote a few remarks of one who, in his day, must have paid considerable attention to these carvings, as he did, indeed, to all other matters connected with the Aborigines. I refer to the late Mr. George French Angas, who says†—"Relative to these tracings or carvings upon the flat surfaces of the rocks of projecting headlands their uses or intentions are now only legendary. The natives say that 'blackfellow make them long ago,' and to convey an idea of antiquity they hold up their fingers and hands, elevate the face, shut the eyes, and say—'murrey-murrey long time ago.' They agree in stating that the tribes did not reside on these spots, assigning as a reason 'too much dibble-dibble walk about.' . . . . They also state that these places where the carvings exist were all sacred to the doctors and conjurors, and were in fact 'koradjee' or priests' ground . . . . . As the whole of these carvings represented indigenous objects, and above all the human figures in the attitudes of the corroboree dances, no other conclusion can be drawn, but that they were of native origin." In a former communication on this subject, when ascribing to Dr. A. Carroll and myself the only attempted explanation of these carvings, I had overlooked this passage of Mr. Angas', but perhaps its obscure method of publication may be pleaded in excuse. His remarks, however, based on the evidence of the early natives, that these were "kooradjee or priests' ground," is pretty conclusive on the subject. Sir Charles Nicholson‡ was of much the same opinion as to their great antiquity, for when describing carvings on the site of what is

* Records Geol. Survey N. S. Wales, 1890, II, Pt. 1, t. 2, f. 6.
† Waugh's Austr. Almanac for 1858, p. 58.
‡ Journ. Anthrop. Inst. Gt. Brit. & Ireland, 1880, IX, p. 31.

now Middle Head Battery, Port Jackson, he based his opinion on the amount of erosion undergone, depth of superincumbent soil, and growth of large trees, also that the old natives could [or would] not give an account of them.

I may remark, that in seeking for an explanation of these carvings, I have made free use of Messrs. A. W. Howitt and J. Fraser's graphic descriptions of the *Bora* ceremony, considering that it was amongst these peculiar observances, that an interpretation was to be found. In the case of the former writer, it is chiefly to the practices of the associated *Murring* that I refer, viz., to the *Wolgal* of the Upper Murray, Murrumbidgee, and Tumut Rivers; the *Ngarego* of the Maneroo Table-land; the *Theddora* of Omeo and the Mitta Mitta River; the Coast-*Murring* from Mallagoota Inlet northwards to the Shoalhaven River; and the *Wiraijuri*, Lower Murrumbidgee as far as Hay.* These five tribes, or perhaps more correctly speaking tribal groups, represent a social aggregate, namely a community bound together, in spite of diversity of class system, by ceremonies of initiation, which, although they vary slightly in different localities are yet substantially the same, and are common to all.† It is to the ceremony of the coast tribes, known as the *Kuringal* that reference is now more particularly made.

I need not repeat the arguments used in a former paper‡ on this subject, but will only add a few further remarks on the male figures supposed to represent *Daramūlŭn* or *Baiamai*, and then take up those not observed in previously recorded carvings. The position in which the male figures are represented is a very characteristic one of some of the magic dances, *i.e.* dances forming an integral part of the *Bora*, and differs from those commonly seen at ordinary corrobories, when the arms and legs are, as a rule, simply extended, and not the former raised above the head, and the latter more or less doubled up under the body. Howitt remarks§ that, amongst the associated community already referred to, at one side of the *Bunan* circle, where the initiate's tooth is knocked out, "the figure of *Daramūlŭn* is cut on some large tree, in the attitude of dancing the magic dance." By the Coast-*Murring*, the figure of this spirit-god, who presided at the *Bora*, is moulded in earth. In the pantomimic representations accompanying a portion of the ceremony the "Rock Wallabies" is performed, and in the attendant dance the "legs are kept somewhat apart, and at each jump the knees are somewhat bent. . . . . at the same time the arms, hanging down, are swung to and fro across the body; this is the whole step and action."‖ It will be observed that here the arms are kept hanging down, but the upward gesture shown in our carvings both of man and women is that by which this community of peoples silently indicate the dreaded spirit or Great Master, *Daramŭlŭn*.¶ This

* Journ. Anthrop. Inst. Gt. Brit. & Ireland, 1884, XIII, pp. 185 & 433.
† *Ibid*, p. 433.
‡ Records Geol. Survey N. S. Wales, 1893, III, Pt. 3, p. 82.
§ *Loc. cit.* p. 447.
‖ Howitt, Journ. Anthrop. Inst. Gt. Brit. and Ireland, 1884, XIII, p. 449.
¶ *Ibid*, p. 442

arm-raising also took place on the part of the *Tutnurring*, or initiates, during the corresponding ceremony, or *Jeraeil* of the neighbouring *Kurnai* Tribe, in South-east Gippsland.* The bent position of the leg is also assumed in some ordinary corroborics and was termed by the late Surveyor-General Mitchell the "corroboree jump."† He says, speaking of the performers—"until each imperceptibly warms into the truly savage attitude of the 'corrobory jump' . . . . . the legs striding to the utmost . . . . . the arms raised and inclined towards the head." Mr. R. Dawson, at one time Chief Agent of the Australian Agricultural Company, who saw this doubling up of the legs at Port Stephens, compares‡ it very happily to the movement in the "limbs of a pasteboard harlequin when set in motion by a string." On the other hand the position of the legs, merely extended, as seen in the carvings at Bantry Bay (Middle Harbour), Flat Rocks (near Manly), Berry's Head, and in the present female figure (Pl. IX, Fig. 14) is by far the commonest one assumed in ordinary dances. It was so with the Hunter and Isis River Blacks,§ amongst the associated *Murring*, and is exhibited in the *Palti* dance, so beautifully illustrated by Angas in his magnificent work on South Australia.‖ It also forms the frontispiece to the second volume of Lt.-Col. Mitchell's "Three Expeditions."

With regard to the head appendages or halo represented in the chief male figure (Pl. IX, Fig. 15), it may be intended for the head-dress of a headman (so-called "chief") only, and by analogy intended to convey an idea of the high position occupied by the prototype of the figure represented by the carving. Head-dresses of this description are not unrecorded in Aboriginal literature. Omitting the problematical drawings published by Sir G. Grey, in N. W. Australia,¶ and lately deciphered, in all probability with a great deal of truth, by the Rev. T. Mathew,** I may refer to the head-dress figured†† by the late R. B. Smyth, consisting of a framework of sticks and cockatoo feathers. This is called *Oogee*, and is used in corroboree at Cape York. Mr. W. T. Wyndham mentions that in the *Ucumble* tribe of New England, the old men in corroboree put *goora* or "glory" on their heads. This is the down of the *Mullion* or Eagle-hawk.‡‡

Now as to the huge footprints. In the *Wiraijuri* tribe, along the Murrumbidgee River, preceding the extraction of the initiate's tooth, amongst other things, "a strip of bark is taken spirally from a large tree down to the ground. This represents a path from the sky to the earth, down which *Daramūlŭn* descended."§§ My reading is that the large footprints (Pl. IX, Figs. 13 *a* and *b*) are simply an extension of this idea, and are intended to represent the footprints of *Daramūlŭn*

* *Ibid*, 1885, XIV., p. 307, *footnote*.
† Three Expeds. Interior E. Australia, 1838, II, p. 5.
‡ Present State of Australia, 1830, p. 61.
§ Journ. Anthrop. Inst. Gt. Brit. and Ireland, 1878, VII, p. 255.
‖ S. Australia Illustrated, 1846, Pls. 15 and 24.
¶ North-west and Western Australia, &c. 2 vols. 8vo. London, 1841.
** Journ. R. Soc. N. S. Wales for 1889 [1890], XXIII, pp. 414–417.
†† Aborigines of Victoria, 1878, I, p. 280, f. 32.
‡‡ Journ. R. Soc. N. S. Wales for 1889 [1890], XXIII, p. 38.
§§ Howitt, Journ. Anthrop. Inst. Gt. Brit. and Ireland, XIII, p. 452, *foot note*.

after he threw his tomahawk at the Emu, during the descent from the sky.* As I have elsewhere pointed out,† in a Rock-shelter in the Burragorang Valley hand-prints are depicted which the old Blacks of the vicinity informed Mr. Maurice Hayes, of Queagong, Burragorang, and my informant, were those of their Deity, made when on a visit to earth. Here we see a modified continuity of the same idea travelling inland from tribe to tribe.

There is an intimate relation between the figures of the Emus and those of the women. *Daramūlŭn* had two wives according to the traditions of the associated peoples already referred to,‡ the "duality" *Ngalabal.* This name, according to Mr. Howitt, is derived from *ngalal*, a sinew, "in reference to the sinewy legs of the Emu, which is *Ngalabal*, and from *bal*, a dual affix." In that portion of the *Bora* ceremony, termed the Ngalabal-dance, *Daramūlŭn's* two wives, the "duality" *Ngalabal*, "are seen to cross the bora circle, glide from the forest past the fire, and to disappear in the gloom beyond."§ This dual woman is not confined to the *Murring* association, but it is represented in the *Kurnai* Tribe, of S. E. Gippsland, by the female duality *Būlūn-Baūkan*,‖ occupying much the same position in their mythology.

Howitt remarks—"I use this word 'duality' as the only one I can think of which expresses the peculiar conception of the supernatural being 'Balum-baukan.' Two Baukans are always spoken of, but at the same time as if inseparable, and having one son, *Bulum-tut*, common to both."¶ In the *Woi-worūng* Tribe, the dual wife, *Ngalabal*, is represented by the two wives of *Bungil* (the star Fomalhaut).** At the conclusion of the ceremonies when, after the extinction of the magic fire, the processions returned to the camp, and the outline of *Daramūlŭn* was moulded in earth by the old men in the attitude of the magic dance, two dances took place, one to the word *Daramūlŭn*, the other to the word *Ngalabal.*†† I have given these extracts from Mr. Howitt's graphic descriptions with the view of showing how intimately the postures assumed in our Idiographic Carvings are associated with the details of known ceremonies, and to account for the presence of the female and male figures, and that of the Emu.

The intimate connection between the figures of the woman and Emu is also demonstrated by some of the tribal food restrictions. The novices are confined to certain forms of sustenance, amongst other things they may not eat of the Emu, "for this is *Ngalabal*, the wife of *Daramūlŭn*, and at the same time the "woman."‡‡

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* *See* Records Geol. Survey N. S. Wales, 1893, III, Pt. 3, p. 85.
† Records Austr. Mus., 1893, II, No. 4.
‡ Howitt, Journ. Anthrop. Inst. Gt. Brit. and Ireland, XIII, p. 450.
§ *Ibid.*
‖ Howitt, *loc. cit.*, 1886, XV, p. 415, *foot note.*
¶ *Ibid.*
** Howitt, *loc. cit.*, 1884 XIII, p. 452.
†† Howitt, Journ. Anthrop. Inst. Gt. Brit. and Ireland, 1884, XIII, p. 452, *footnote.*
‡‡ *Ibid*, p. 456.

In at least one set of carvings, that at Bantry Bay, we have seen the outlined figure of a large tomahawk. The most distant of the associated peoples, the *Wiraijuri*, moulded this weapon as one of their representative objects in the *Bora*, and which, the initiates were informed was thrown by *Daramūlŭn* after the Emu, as he descended from on high.* As a portion of the same idea, our local Blacks, I believe, outlined the footprints of the Emu, to be seen in a few rare instances on some of the sandstone tables. These imprints are supposed to have been made when the Emu was endeavouring to escape from the Spirit-god. The *Wiraijuri* also moulded the figure of the bird itself, where it fell after the tomahawk was thrown.

This veneration for the Emu extended much further north than Port Jackson, for amongst the Hunter and Isis Rivers Blacks a naturally-bent tree was selected near the head of the recumbent prone figure, also moulded by them. On the bent tree were cut prints of the Emu's feet, and along it was carried a stuffed bird as if treading in the footmarks.†

In a similar manner to the derivation of *Ngalabal* by Howitt, Dr. John Fraser has sought to explain the word *Daramūlŭn*. In the *Kamilaroi* legends he informs us "*Dhar* seems to have a twofold aspect, and hence the *mūlŭn* in his name may be the word *bulla*, 'two.'"‡

It is, therefore, by applying the *Bora* customs of the associated *Murring*, as depicted by Howitt, that I seek to explain the introduction of the female figure, accompanied by that of the Emu, amongst these carvings, and this is supported by the fact that the former figures and those of the men are represented in the attitude of the dance, probably one of the magic dances.

Dr. Fraser's derivation of the word *Daramūlŭn* has already been given. In a later publication,§ he believes the first syllable *Dara*, or *Dhara*, to have its source in "*dara, dri*, a very old language root meaning to protect." According to the Rev. C. Greenway,‖ however, *Turramūlun* [:*Daramūlŭn*] means in the Kamilaroi language, "leg on one side only," "one legged." Now we know that the Kamilaroi organisation existed over a very large portion of Northern New South Wales. Can this derivation applied to *Daramūlŭn* be in any way connected with the conception of the large single leg (Pl. IX, Fig. 4) of our present carvings? It is quite unconnected with any of the other figures, and there is the bare possibility that its representation is an effort on the part of the local "doctor"-sculptor to convey the Kamilaroi conception of the dreaded spirit, as the more perfect male figures are believed by the writer to express those of the tribes further to the south, possessing *Murring*

* *Ibid*, p. 452.
† Ridley, Kamilaroi and other Austr. Languages, 1875, p. 156.
‡ Journ. R. Soc. N. S. Wales, for 1891 [1892], XXV., p. 275. In a letter kindly communicated to me by Dr. Fraser, the latter remarks: "It is clear to me that *Daramūlŭn* was a dual divinity, somewhat the same way as Castor and Pollux, and that he is the representative of *Baiamai* in the work of creation, and in communicating with men. The *Wiradhari* dialect calls him *Darawirgal*, from *Wirgal*, the tree in the form of a rainbow, which grows out of his thigh."
§ Aborigines of N. S. Wales, 1892, p. 19.
‖ Journ. Anthrop. Inst. Gt. Brit. and Ireland, 1878, VII, p. 242.

organisation. No doubt the Hawkesbury Tribes must have been influenced to some extent at least by the traditions on both sides of them, bearing in mind that the Kamilaroi cult, strictly speaking, seems to have reached its southern limit at or about Maitland on the Hunter River.*

Of the dilly-basket (Pl. IX, Fig. 11) I am not at present able to offer any explanation.

The only suggestion I am able to propose for the bird-like object (Pl. IX, Fig. 3) is that it is intended either for a Flying-fox, or an Eagle-hawk. This bird was in some tribes the representatives of a totem subdivision within one of the class systems, but the Coast-*Murring*, "had, however, with male descent lost the class divisions, and the totems only remained as magical names."† There is the possibility that it may have remained amongst our Blacks in this sense.

The Iguana (Pl. IX, Fig. 1) and the Opossum (Pl. IX, Fig. 10) were also totem names, but as so little seems to have been preserved connected with the inner organisation of the Port Jackson and neigbouring tribes, I merely throw out these remarks as suggestions. It may, however, be pointed out that Dr. J. Fraser has recently figured‡ a tree from the upper circle of a *Bora* ground in N. S. Wales, on which the figure of a large Iguana was carved, accompanied by two male figures, one with the arms elevated.

I may, perhaps, be allowed to anticipate criticism by indicating the one weak point in the deductions I have drawn from these carvings. Lieut.-Col. Collins, in his "English Colony in N. S. Wales," the only work giving a reliable description of the *Bora* ceremonies, or any ceremonies at all, of the Port Jackson Tribes, represents them as taking place in open glades of the woods. Collins merely illustrates the more openly performed scenes in the ceremonies, and there is no internal evidence to show that he was present at all of them. In fact, from the well-known reluctance on the part of the Blacks all over the Continent, to admit the White to a participation in their mysteries, we may conclude with tolerable certainty that he was not. However, be this as it may, we have every reason to believe that as far as they go, Collins' depictions are most faithful representations of what he saw in those early days.

V.—Distribution of the Carvings.

We at present know comparatively little about the distribution of these carvings, except in our own immediate district. As the coastal area is left behind, the place of these rock-sculpturings seems to be taken by Idiographic Drawings. At the same time Ridley in describing§ the rites of the *Wailwun* Tribe, says that on one of the stony ridges between the Barwon and Narran Rivers, is a hole in the rock shaped like a man, but two or three times larger. In this the Blacks believed *Baiamai*

* Howitt, Journ. Anthrop. Inst. Gt. Brit. and Ireland, 1889, XVIII, p. 33.
† Howitt, Journ. Anthrop. Inst. Gt. Brit. Ireland, 1889, XVIII, pp. 41 and 48.
‡ Aborigines of N. S. Wales, 1892, p. 16, 3rd plate.
§ Kamilaroi and other Austr. Languages, 1875, p 136.

used to rest himself, during his visits on earth. Mr. W. A. Cuneo, of Thirlmere, has lately discovered carvings in the Burragorang Valley, at Apple Grove, on the flat surface of a rock of the Permo-Carboniferous System. They consist of the figures of a fish and the Emu. If it be ultimately shown that these carvings are in a great measure confined to what may be called the Hawkesbury Basin, using this term in its most extended sense, the occurrence of them further inland, throughout the eastern portions of New South Wales, may perhaps be accounted for by what Mr. Howitt has well expressed by the term "by attendance," * *i.e.*, the presence of those members of other tribes who were privileged, either by blood relationship, or knowledge of the mysteries in practice. Many similar ceremonies are believed by the same eminent authority to have extended over large areas. For instance, he lays down a northerly extension by a line drawn through what is now Sydney to the Lachlan River, down the latter to Balranald,† and of course southwards to those tribes already mentioned. He has, to my mind, conclusively shown that the Coast *Murring* attended the Boras of the *Kátūngal*, or "Sea-coast people," and of the *Kūrial* or "Northern people." The *Bora* of the Coast *Murring* called the *Kūringal* may be taken as the type of this large community.

Whatever may have been the origin of these carvings, it is interesting to be able to locate them chiefly within the territory of the two principal tribes inhabiting the Port Jackson District—the *Cammerragal* on the north, and the *Gweagal* on the south of the estuary.

The *Cammerragal*, or people of *Cammerray* or "North Shore," were a numerous and powerful tribe, extending from North Head to the Lane Cove River, north to the Hawkesbury, and thence eastwards to the coast again.‡ The *Gweagal*, or people of *Gwea*, on the contrary, possessed the country from the south shore of Port Jackson to away beyond Botany Bay.§ Collins tells us that the Cammerragals attended the *Bora*‖ of the neighbouring sub-tribes, and possessed the exclusive right of knocking out the initiate's tooth. According to Howitt, the suffix *gal* means those "of" or "belonging to"—thus the Coast *Murring* applied the word *Kátūngal* to all other peoples located on either side of them, in one direction into Gippsland, and in the other beyond Sydney.¶ It is a noteworthy fact that by far the most interesting groups of carvings are found in the country of the *Cammerragal*.

Going still farther afield, it is remarkable to find that even in Sarawak (North Borneo) representations of the human figure exist on rocks. Mr. F. Galton mentions the sprawling figure of a man carved in high relief on a large rock, and of the natural size, face downwards.**

* Journ. Arthnrop. Inst. Gt. Brit. and Ireland, 1884, XIII, p. 434.
† *Ibid.* p. 435.
‡ Hon. R. Hill, Notes on the Aborigines of N. S. Wales (Chicago Exposition, 1893), 1892, p. 1.
§ Collins, English Colony in N. S. Wales, 1804, p. 353. The Hon. G. Thornton locates this tribe on the north and south shores of Botany Bay (*Notes on the Aborigines of N. S. Wales* (*Chicago Exposition*, 1893), 1892, p. 7.
‖ Or, as it was there called, the *Yoolangh* (Thornton, *loc. cit.*)
¶ Howitt, *loc. cit.* 1886, XV, p. 418.
** Journ. Anthrop. Inst. Gt. Brit. and Ireland, 1892, XXI, p. 282.

XV.—On the Artificial Method of Lighting the Jenolan Caves: By W. S. LEIGH, Superintendent of Caves.

FROM the time of the discovery of the Jenolan Caves in 1841 up to 1868, the year in which they were reserved and brought under Government control, the most primitive of lights, viz., the torch and candle, seem to have been in general use for illuminating purposes. This means of lighting is responsible for the many smoke-discoloured patches noticed on the walls and ceilings of the older caves at Jenolan, and perhaps more so at the other principal cave centres, viz., Yarrangobilly, Wombeyan, and Wellington, where visitors had more of a free hand for a longer period. Curiously enough, these smoke patches mostly occur at those places in the caves where it has been found necessary during an inspection to call a halt; for instance, at the mouth of a narrow, intricate passage, or at the top of a steep declivity, where a portion of the party would be kept waiting while the leaders made headway.

This means of lighting would certainly give one an idea of the size of a cavity, but it remained for the later introduction, the magnesium lamp, to more effectually present to view the stalactitic adornments or beauty of a cave. In fact, as a means of illuminating any out-of-the-way nook or cranny, where the light has to be concentrated on one particular spot, this lamp even surpasses the latest introduction, the electric light. For general purposes however, by reason of the large area its rays will pierce, and being smokeless, a great consideration in an ill-ventilated cave, the electric light is certainly an improvement on anything yet introduced.

Electricity was first adopted as an illuminating agent at Jenolan, in the then principal cave, the "Imperial," in January, 1887. The motive power was a six-horse vertical engine, connected to a small dynamo capable of lighting twenty-five incandescent lamps, arranged in circuits of that number throughout the cave; it being only necessary for the guide, on reaching the end of a circuit, to switch on to the next, and so on. This means of lighting proving a success, the question of its extension naturally arose, but as the existing motive power would be inadequate, it was decided, on the suggestion of the late Government Geologist, Mr. C. S. Wilkinson, F.G.S., &c., to substitute water in lieu of steam for driving the dynamo. For this purpose advantage was taken of the never-failing supply and fall afforded by the underground river at Jenolan, by means of which ample power would be made available for all requirements, and the lights, in addition to being more constant, would be run on a far more economical basis.

An underground river rises to the surface about fifty feet below the northern entrance of the Grand Arch, near the junction of the Cave and McEwan's Creeks, at the rate of about one thousand gallons per minute. From this point, where it

is dammed, it is carried in wrought-iron pipes, twenty-two inches in diameter,* supported by concrete piers, a distance of six hundred and seventy feet, along the bed of Cave Creek, to the top of the first waterfall, a gradual fall of ten feet being allowed in this distance. As a further sheer fall of thirty-five feet to the bottom of the water-fall was obtainable, and this head of water alone being quite ample, the turbine water-wheel was erected in a bend of the creek at the bottom, thus a total fall of about forty-five feet from the dam was secured.

The turbine, one of Messrs. James Leffel and Co.'s Ten-inch Improved, is enclosed in a globe casing, the inlet being fifteen inches in diameter. The wheel is connected to a vertical spindle and now runs at a speed of eleven hundred revolutions per minute, the diameter of the pulley being regulated by that of the hundred-light Crompton Dynamo, to which it is connected direct by belt gearing, the dynamo requiring a speed of one thousand two hundred and sixty revolutions per minute.

With a circuit of one hundred incandescent lamps, the turbine exerts a force of about ten horse power, but in regular practice, in order to ensure the best results, the dynamo is not taxed to its full strength, a margin being allowed, which is effected by slightly reducing the number of lamps in the circuit.

As the flow of water through the turbine can be regulated to a nicety, its running has proved far more regular than that of the original motive power, the steam engine, consequently the lights have been much steadier, and in fact more brilliant.

Considering the difference in cost of generating steam in the one case and making use of running water in the other, also the great saving in labour in respect to the latter, we may conclude that the adoption of water as the motive power at Jenolan has answered most satisfactorily.

I may add, that having ample power at disposal, the extension of the electric light into the Lucas Cave has been decided upon, in fact the work is now nearing completion.

Another dynamo being required, it was found necessary to re-arrange the machines in the turbine house. Instead of driving direct from the turbine, as formerly, the two machines, the "Crompton" and the new "Western" dynamos, will be driven by means of counter shafting, the former for the Imperial and the latter for the Lucas Cave. In addition to the ordinary incandescent lamps, with which the passages will be lighted, six arc lamps will also be erected in the Lucas Cave, arranged so as to light up the large chambers.

By reason of the spaciousness of this cave, the arc lights will produce a novel and striking effect, and be the means of making an inspection of it quite as interesting as that of any cave at Jenolan.

* These pipes were kindly supplied by the Department of Public Works, they having formerly formed part of those in use for the Sydney Temporary Water Supply. If ordered specially, a pipe of smaller diameter would have answered this purpose.

XVI.—The Australian Geological Record for the Year 1893, with Addenda for 1891 and 1892: by R. ETHERIDGE, Junr., Palæontologist and Librarian, and W. S. DUN, Assistant Palæontologist and Librarian.

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XVII.—A Tabular List of the Bores and Water-Augers put down by the Department of Mines and Agriculture, N. S. Wales, and mentioned in the Reports of the Department: by W. S. DUN, Assistant Palæontologist and Librarian.

THIS list has been compiled with the object of systematising and simplifying reference to the numerous Bores and Water-augers that have been put down from time to time by the Department of Mines and Agriculture.

There are many cases in which the information given is very meagre, and, as a rule, no attempt has been made to fill these blanks. For instance, in many of the Bores and Water-augers put down in the Cretaceous Basin of the north-western portion of the Colony, the Cretaceous beds are almost always overlaid by more or less thick Post-Tertiary deposits, so that in many cases it is almost impossible to say—from the bore journals—where the more recent deposits end and the Cretaceous begin. This will account for the use of the term "Cretaceous ?," which signifies that no Palæontological evidence of a definite character has been obtained from the bore in question.

The plan adopted is the following:—(1) The name by which the Bore or Water-auger is generally known is given; (2) the district or locality; (3) the parish when stated; (4) the county; (5) the approximate geological horizon and formations passed through; (6) the depth in feet and inches; (7) the purpose for which it has been put down; and (8) the reference to the Report from which the evidence is obtained.

In the name column the numbers and letters are given as in the original references, but those in round brackets have been put in by myself.

Name.	Locality.	Parish.	County.	Geological Formation.	Depth in feet, &c.	Purpose	Reference.
A. A. Co.'s Platt's Estate.	Platt's Estate, Newcastle.	Newcastle..	Northumberland.	Newcastle, or Upper, Coal Measures.	1,049·0	Coal ..	1879, pp. 207, 208.
Adamstown	Adamstown	,, ..	,,	,, ,, ..	202·0	,, ..	1885, p. 160.
,, ...	,, ...	,, ..	,,	,, ,, ..	77·6	,, ..	1883, p. 188.
Allison's	Mullet Ck., Hawkesbury River.	Patonga ..	,,	Hawkesbury Sandstone, Chocolate Shales.	1,300·0	,, ..	1879, to face p. 208.
Ana Bay (1)	Ana Bay	Tomaree ..	Gloucester	Æolian; Carboniferous; Porphyry.	318·1	,, ..	1890, p. 157.
,, (2)	,, ...	,, ..	,,	Æolian and Carboniferous.	449·5	,, ..	1890, p. 159.
,, (3)	,, ...	,, ..	,,	Æolian; Carboniferous; Basalt, Serpentine.	1,213·1	,, ..	1891, Diag. 10.
Angledool (1) ..	Sandridge Reserve, Angledool.	Mundoo ..	Finch	Post-Tertiary	123·6	Water..	1884, p. 230.
,, (2) ..	,, ..	,, ..	,, ...	,, ...	54·0	,, ..	1884, p. 231.
,, (3) ..	,, ..	,, ..	,, ...	,, ...	63·0	,, ..	1884, p. 232.
,, (4) ..	,, ..	,, ..	,, ...	,, ...	58·0	,, ..	1884, p. 233.
,, (5) ..	,, ..	,, ..	,, ...	,, ...	133·0	,, ..	1884, p. 234.
,, (6) ..	,, ..	,, ..	,, ...	,, ...	490·6	,, ..	1884, p. 235; 1885, p. 186.

Name.	Locality.	Parish.	County.	Geological Formation.	Depth in feet, &c.	Purpose	Reference.
Apple-tree Creek	Apple-tree Creek, Minmi.	Hexham ..	Northumberland.	Newcastle, or Upper Coal Measures.	681·3	Coal ..	1885, p. 163.
Araluen, No. 1..	Araluen	....	St. Vincent	Post-Tertiary and Granite.	24·0	....	1883, p. 215.
,, No. 2..	,, ...	....	,, ..	,, ,, ..	24·6	....	1883, p. 215.
,, No. 3..	,, ...	....	,, ..	Post-Tertiary.....	30·6	....	1883, p. 216.
,, No. 4..	,, ...	....	,, ..	,, ...	7·0	Gold (little).	1883, p. 216.
,, No. 5..	,, ...	....	,, ..	Post-Tertiary and Granite.	41·3	....	1883, p. 217.
,, No. 6..	,, ...	....	,, ..	,, ,, ..	41·5	....	1883, p. 217.
Ash Island	Ash Island	Newcastle..	Northumberland.	Newcastle, or Upper Coal Measures.	1,102·4	Coal ..	1888, pp. 220, 221.
Ballimore, 1	Ballimore	Murrungundie.	Lincoln ..	Ballimore Coal Measures.	561·6	,, ..	1886, p. 188; 1891, App. 13.
,, 2	,, ...	,, ..	,, ..	,, ,, ..	794·6	,, ..	1887, p. 188.
,, 3	,, ...	,, ..	,, ..	,, ,, ..	1,101·4	,, ..	1887, p. 189; 1888, p. 217.
Barber's Creek..	Barber's Creek	Marulan ..	Argyle	Mittagong, or Upper Coal Measures.	670·6	,, ..	1883, p. 193.
Barrigun, No. 1	Barrigun Holding..	....	Culgoa	Post-Tertiary and Cretaceous.	192·2	Water..	1885, p. 193.
Barrigun	,, ..	Barrigun ..	,, ...	,, ,, ..	745·0	,, ..	1891, App. 62.
Belalie (1)	Belalie Holding	....	Irrara	,, ,, ..	1,600·0	,, ..	1891, App. 58.
,, (2)	,, 2 mls. S. of 12 ml. peg Queensland Boundary, E. of Warrego.	....	Culgoa	,, ,, ..	1,693·0	Water..	1891, App. 32.
,, (3)	Belalie Holding	....	Irrara	,, ..	1,160·0	,, ..	1891, App. 33.
Berrima Colliery	Berrima	....	Camden ..	Mittagong, or Upper Coal Measures.	92·6	Coal ..	1883, p. 139.
Bingara (1)	Jones' Flat, Bingara	Bingara ..	Murchison	Post-Tertiary and Serpentine.	36·6	Water .	1886, p. 199.
,, (2)	Gaol Well, Bingara	,, ..	,,	Post-Tertiary.....	47·0	,, ..	1886, p. 199.
,, (3)	Cemetery Flat, Bingara.	,, ..	,,	Post-Tertiary and Silurian ?	63 6	,, ..	1886, p. 200.
,, Upper (1)	Upper Bingara	,, ..	,,	Granite	117·2	....	1885, p. 171.
,, ,, (2)	,, ...	,, ..	,,	Diorite.....	140·0	....	1885, p. 172.
,, ,, (3)	,, ...	,, ..	,,	,, ...	103·0	....	1885, p. 173.
Black Gully	Emmaville	Strathbogie North.	Gough	Basalt and Granite ..	74·5	Tin....	1883, p. 194.
Bourke (1).....	18 m. W. of Bourke	....	Gunderbooka.	Post-Tertiary and Cretaceous ?	194·4	Water..	1883, p. 198.
,, (2).....	,, ,, ,,	....	,,	,, ,, ..	198·3	,, ..	1883, p. 199.
,, (1).....	51 m. W. of Bourke	Goonery ..	Barrona ..	Post-Tertiary.....	89·2	,, ..	1883, p. 200.
,, (2).....	,, ,,	,, ..	,, ..	,, ...	34·6	,, ..	1883, p. 201.
,, (3).....	,, ,,	,, ..	,, ..	,, ...	114·0	,, ..	1883, p. 201.
,, (4).....	,, ,,	,, ..	,, ..	,, ...	103·0	,, ..	1883, p. 202.
,, (5).....	,, ,,	,, ..	,, ..	Post-Tertiary and Cretaceous ?	200·8	,, ..	1883, p. 203.
,, (A).....	18 m. W. of Bourke	....	Gunderbooka.	Post-Tertiary.....	194·6	,, ..	1884, p. 222.
,, (B).....	51 m. W. of Bourke	Goonery ..	Barrona ..	Post-Tertiary and Cretaceous ?	89·2	,, ..	1884, p. 222, 1891, App. 15.
,, (B^1)	51 m. 5 ch. W. of Bourke.	,, ..	,, ..	,, ,, ..	34·6	,, ..	1884, p. 224.
,, (B^2)	51 m. W. of Bourke.	,, ..	,, ..	Post-Tertiary	114·0	,, ..	1884, p. 225.
,, (B^2 2nd.)	,, ,, ..	,, ..	,, ..	,, ...	103·0	,, ..	1884, p. 226.
,, (B^3)	51½ m. W. of Bourke	,, ..	,, ..	Post-Tertiary and Cretaceous ?	200·8	,, ..	1884, p. 227.
,, (C)	18 m. W. of Bourke	....	Gunderbooka.	,, ,, ..	198·3	,, ..	1884, p. 228.
,, (D)	57 m. W. of Bourke	....	Barrona ..	,, ,, ..	545·6	,, ..	1884, p. 229; 1885, p. 183.
,, (E)	75 mile-post Bourke to Wanaaring Road.	Wanga	,, ..	,, ,, ..	960·0	,, ..	1885, p. 184; 1886, p. 195; 1891, App. 12.
,, (F)	94 mile-post Bourke to Wanaaring Road.	....	,, ..	,, ,, ..	321·7	,, ..	1885, p. 185.
,, (F^2)	101½ mile-post Bourke to Wanaaring Road.	Paroo	Irrara	,, ,, ..	965·0	,, ..	1887, p. 209; 1891, App. 14.
,, No. 4....	Bourke.....	East Bourke	Cowper ..	Post-Tertiary; Cretaceous ? and Silurian ?	1,467·0	,, ..	1891, App. 8.
Breakfast Creek.	Breakfast Creek ..	Penrith ..	Cumberland.	Hawkesbury Sandstone.	787·1	Coal ..	1884, p. 180.

Name.	Locality.	Parish.	County.	Geological Formation.	Depth in Feet, &c.	Purpose	Reference.
Broken Hill	Broken Hill	Picton ..	Yancowinna.	Gneiss and Granite ..	2,123·9	....	1887, p. 191; 1888, p. 218; 1889, p. 152; 1890, p. 161.
Buckanba	Buckanba Holding..	Wygilla....	Rankin....	Recent and Post-Tertiary.	725·0	Water	1891, App. 20.
Bulli	Bulli	....	Camden ..	Upper Coal Measures .	805·3	Coal ..	1891, Diag. 12.
,, (2).....	,, ...	....	,, ..	,, ..	865·4	,, ..	1892, p. 79.
,, (3).....	,, ...	....	,, ..	,, ..	.....	,, ..	1892, p. 81.
Bundanoon	Bundanoon.....	....	Camden ..	Coal Measures	720·3	Coal ..	1886, p. 185.
,, (2) ..	,, ...	....	,,	,,	380·1	,, ..	1887, p. 186.
Burwood	Concord Tannery, Burwood.	Concord ..	Cumberland.	Hawkesbury—Wianamatta Series.	218·0	Water	1884, p. 237.
Buttai	Buttai	Stockrington.	Northumberland.	Tomago, or Middle Coal Measures.	1,800·0	Coal .	1889, p. 145.
Catherine Hill Bay.	Catherine Hill Bay	Wallarah ..	,,	Newcastle, or Upper Coal Measures.	262·9	,, ..	1876, p. 139.
Cessnock	Cessnock	Cessnock ..	,,	Greta, or Lower Coal Measures.	1,220·0	,, ..	1890, p. 155. 1891, Diag. 7.
City Railway Extension.	Sydney.....	Sydney....	Cumberland.	Hawkesbury Sandstone.	11·0 to 64·0	....	1884, pp. 192-212.
Clarence Siding..	Clarence Siding....	....	Cook.....	Hawkesbury Sandstone, Chocolate Shales; Upper Coal Measures.	1,040·6	Coal ..	1885, p. 155. 1886, p. 183. 1887, p. 187.
Coalcliff.....	Coalcliff	Southend..	Cumberland.	,, ,,	2,350·0	,, ..	1879, p. 208.
Coal Point	Coal Point, Lake Macquarie.	Awaba	Northumberland.	Newcastle, or Upper Coal Measures.	902·0	,, ..	1884, p. 181.
Cockle Creek ..	Cockle Creek, Lake Macquarie.	Teralba ..	,,	,, ,,	803·2	,, ..	1884, p. 183.
Cobar Copper Mine (i-viii).	Cobar Copper Mine	....	Robinson..	Silurian, &c.	24·0–3 26·0	Copper	1884, pp. 186-187
Colo Vale (1)....	Colo Vale	Mittagong.	Camden ..	Hawkesbury Sandstone; Upper Coal Measures.	345·0	Coal ..	1884, p. 171.
,, (2)....	,, ...	,, ..	,, ..	,, ,,	880·7	,, ..	1884, p. 172.
,, (3)....	,, ...	,, ..	,, ..	,, ,,	947·8	,, ..	1884, p. 177.
,, (4)....	,, ...	,, ..	,, ..	,, ,,	1,181·0	,, ..	1884, p. 178. 1885, p. 161.
Cremorne (1)..	Cremorne	Willoughby	Cumberland.	Hawkesbury Series, Narrabeen Shales, Chocolate Shales; Newcastle, or Upper Coal Measures.	3,095·0	,, ..	1890, p. 159. 1891, Diags. 10, 11.
,, 2 ..	,, ...	,,	,,	,, ,,	2,929·0	,, ..	1892, p. 77. 1893, p. 77.
Dempsey Island	Dempsey Island ..	Newcastle .	Northumberland.	Newcastle, or Upper Coal Measures.	933·0	,, ..	1884, p. 182.
,,	,, ,, ..	,, ..	,,	,, ,,	2,001·7	,, ..	1885, p. 166.
Dora Creek	Dora Creek, Lake Macquarie.	Cooranbong.	,,	,, ,,	475·10	,, ..	1883, p. 186.
Doughboy Hollow.	Doughboy Hollow..	....	Buckland ..	Coal Measures	283·5	,, ..	1892, p. 75.
Dunlop (1).....	Dunlop Holding ..	Singorramba.	Barrona ..	Post-Tertiary and Cretaceous.	620·0	Water .	1891, App. 24.
,, (2).....	Dunlop Holding, 12 miles S. of No. 1 Bore.	Goolgumbla.	Landsborough	,, ,,	940·0	,,	1891, App. 25.
,, (3).....	Dunlop Holding, 8 miles S.E. of No. 2 Bore.	Coonong or Coree.	,,	,, ,,	860·0	,,	1891, App. 26.
,, (4).....	Dunlop Holding ..	Coonong ..	,,	,, ,,	750·0	,,	1891, App. 27.
,, (5).....	,, ,, ..	Tindeanbah	,,	,, ,,	1,200·0	,,	1891, App. 28.
Dunumbral	Dunumbral Holding	....	Finch	,, ,,	2,070·0	,,	1891, App. 23.
Fassiefern	Fassiefern	Awaba	Northumberland.	Newcastle, or Upper Coal-measures.	1,153·9	Coal ..	1888, p. 216. 1889, p. 151.
,, ...	,, ...	,, ...	,,	,, ,,	528·9	,, ..	1889, p. 147.
Ferndale Est. (1)	Ferndale Estate ..	Newcastle..	,,	,, ,,	180·0	,, ..	1880, p. 206.
,, (2)	Ferndale Est. Gravel Quarry.	,, ..	,,	,, .	111·7	,, ..	1880, p. 206.
,, (3)	,,	,, ..	,,	,, ,,	102·0	,, ..	1880, p. 206.
,, (4)	,,	,, ..	,,	,, ,,	100·0	,, ..	1880, p. 206.
Flaggy Creek ..	Flaggy Creek	Kahibah ..	,,	,, ,,	483·1	,, ..	1880, pp. 206-208
,, (2)	Flaggy Creek, near Red Head Lagoon.	,, ?..	,,	,, ,,	337·5	,, ..	1881, pp. 121-125
,, (3)	Red Head Lagoon, ½-mile from.	,, ..	,,	,, ,,	....	,, ..	1881, p. 122.
Folly Coal-fields	Waratah	Newcastle..	,,	,, ,,	383·10	,, ..	1886, p. 191.

Name.	Locality.	Parish.	County.	Geological Formation.	Depth in Feet, &c.	Pur ose	Reference.
Forbes (1)	Forbes	....	Ashburnham.	Post-Tertiary	100·0	Water..	1886, p. 201.
,, (2)	,, ...	....	,,	Post-Tertiary and Silurian.?	104·0	,,	1886, p. 202.
,, (3)	,, ...	....	,,	,, ,,	74·6	,,	1886, p. 203.
,, (4)	,, ...	....	,,	,, ,,	57·6	,,	1886, p. 204.
,, (5)	,, ...	....	,,	,, ,,	105·0	,,	1886, p. 205.
,, (6)	,, ...	....	,,	,, ,,	80·6	,,	1887, p. 199.
,, (7)	,, ...	....	,,	,, ,,	151·6	,,	1887, p. 200.
,, (8)	,, ...	....	,,	,, ,,	144·0	,,	1887, p. 201.
,, (9)	,, ...	....	,,	,, ,,	146·0	,,	1887, p. 202.
,, (10)	,, ...	....	,,	,, ,,	123·0	,,	1887, p. 203.
,, (11)	,, ...	....	,,	,, ,,	164·0	,,	1887, p. 204.
,, (12)	,, ...	....	,,	,, ,,	127·0	,,	1887, p. 205.
,, (13)	,, ...	....	,,	,, ,,	184·6	,,	1887, p. 206.
,, (14)	,, ...	....	,,	,, ,,	193·6	,,	1887, p. 207.
Fort Bourke....	Fort Bourke Holding.	....	Gunderbooka.	Post-Tertiary and Cretaceous.	1,284·0	,,	1891, App. 55.
Fullerton Cove..	Fullerton Cove	Newcastle..	Northumberland.	Newcastle, or Upper, Coal Measures.	954·6	Coal ..	1883, p. 195.
Girilambone (A)	Girilambone	....	Cambelago	Post-Tertiary	155·6	Water..	1883, p. 208.
,, (B)	,, ...	....	,,	,, ...	120·0	,, ..	1883, p. 209.
,, (C)	,, ...	....	,,	,, and Silurian?	100·3	,, ..	1883, p. 210.
,, (D)	,, ...	....	,,	Post-Tertiary	112·6	,, ..	1883, p. 211.
Gladesville 1.. ..	Gladesville Asylum	Ryde.....	Cumberland	Hawkesbury Sandstone.	442·1	,, ..	1883, p. 189.
,, 2...	,, ,,	,, ...	,,	,, ,,	197·10	,, ..	1883, p. 190.
,, 3....	,, ,,	,, ...	,,	,, ,,	365·3	,, ..	1883, p. 191.
Glen Oak	Seaham	Seaham ..	Durham ..	Coal-Measures and tuffs.	501·0	Coal ..	1889, p. 153.
Goodooga 1	Goodooga	....	Culgoa	Post-Tertiary and Cretaceous (?)	104·0	Water.	1885, p. 191.
,, 2	,, ...	....	,, ..	,,	132·0	,, ..	1885, p. 192.
Gorion Station, 1	Gorion Station, Narrabri.	....	Nandewar..	Post-Tertiary	218·7	,, ..	1884, p. 242.
,, ,, 2	,,	....	,, ..	,, ...	271·6	,, ..	1884, p. 243.
,, ,, 3	,,	....	,, ..	,, ...	159·6	,, ..	1885, p. 196.
,, ,, 4	,,	....	,, ..	,, ...	194·0	,, ..	1885, p. 197.
,, ,, 5	,,	....	,, ..	,, ...	151·0	,, ..	1885, p. 198.
,, ,, 6	,,	....	,, ..	,, ...	173·6	,, ..	1885, p. 199.
Grafton, 1.....	Grafton	....	Clarence ..	,, ...	43·6	,, ..	1883, p. 212
,, 2.....	,, ...	....	,, ..	,, ...	46·0	,, ..	1883, p. 213.
,, 3.....	,, ...	....	,, ..	,, ...	21·0	,, ..	1883, p. 213.
,, 4.....	,, ...	....	,, ..	,, and Clarence Series.	184·0	Water and Coal	1883, p. 214.
,, [5]	,, ...	....	,, ..	,,	184·0	,, ..	1884, p. 236.
Gulgong 1-3....	Gulgong	....	Phillip	Tertiary	163, 205, 168	Drift and Basalt.	1890, pp. 143-147
,, 4-8....	,, ...	....	,, ..	,, ...	120-154	Basalt and Drift.	1891, Diags. 1-5.
Gunnedah 1....	Gunnedah	....	Pottinger..	Post-Tertiary	53·0	Water..	1883, p. 204.
,, 2....	,, ...	....	,, ..	,, ...	25·0	,, ..	1883, p. 204.
,, 3....	,, ...	....	,, ..	,, ...	23·0	,, ..	1883, p. 204.
,, 4....	,, ...	....	,, ..	,, ...	40·11	,, ..	1883, p. 204.
,, 5....	,, ...	....	,, ..	,, ...	59·9	,, ..	1883, p. 205.
,, 6....	,, ...	....	,, ..	,, ...	40·6	,, ..	1883, p. 205.
,, 7....	,, ...	....	,, ..	,, ...	30·0	,, ..	1883, p. 205.
,, 8....	,, ...	....	,, ..	,, ...	48·0	,, ..	1883, p. 206.
,, 9....	,, ...	....	,, ..	,, ...	33·6	,, ..	1883, p. 206.
,, 10....	,, ...	....	,, ..	,, ...	132·3	,, ..	1883, p. 207.
,, ...	,, ...	....	,, ..	,, ...	132·3	,, ..	1884, p. 238.
Hamilton 1	Hamilton.....	Newcastle..	Northumberland.	Newcastle, or Upper, Coal Measures.	323·0	Coal ..	1884, p. 188.
,, 2	,, ...	,, ..	,, ..	,, ,,	200·6	,, ..	1884, p. 189.
,, 3	,, ...	,, ..	,, ..	,, ,,	200·8	,, ..	1884, p. 190.
,, 4	,, ...	,, ..	,, ..	,, ,,	211·10	,, ..	1884, p. 191.
Hay 1.....	Gunbar Road	....	Waradgery	Post-Tertiary and Cretaceous?	400·0	Water..	1885, p. 204 1886, p. 205.
,, 2	,, ...	....	,, ..	,, ...	385·1	,, ..	1887, p. 208
Heathcote.....	Heathcote	Heathcote	Cumberland	Hawkesbury Sandstone; Upper Coal Measures.	1,085·7	Coal ..	1885, p. 176.
Hexham Island..	Hexham Island	Hexham ..	Northumberland.	Newcastle, or Upper Coal Measures.	702·4	,, ..	1888, p. 219.
Holt-Sutherland, Botany.	Holt-Sutherland Estate, Botany.	Sutherland	Cumberland	Hawkesbury Sandstone, Chocolate Shales.	2,200·0	,, ..	1879, p. 208.
,, ..	,, ..	,, ..	,, ..	,, ,,	1,003·6	,, ..	1883, p. 197
,, ..	,, ..	,, ..	,, ..	Hawkesbury Series; Upper Coal Measures	2,307·8	,, ..	1886, p. 189.

Name.	Locality.	Parish.	County.	Geological Formation.	Depth in Feet, &c.	Purpose	Reference.
Joadja 1	Joadja	....	Camden	Upper Coal Measures.	365·1	Coal	1888, p. 208.
,, 2	,,	....	,,	,, ,,	882·0	,,	1888, p. 209.
,, 3	,,	....	,,	,, ,,	256·7	,,	1889, p. 142.
,, 4	,,	....	,,	,, ,,	490·11	,,	1889, p. 143.
,, 5	,,	....	,,	,, ,,	357·2	,,	1889, p. 150. 1890, p. 153.
Kallara 1	Kallara Holding, Mullyee Well.	Mulyee....	Killara	Post-Tertiary	46·0	Water.	1891, App. 42.
,, 2	Kallara Holding, Wee Watha.	Undelcawa	,,	,, ...	140·0	,,	1891, App. 43.
,, 3	,, ,,	Binbooker.	,,	,, and Cretaceous ?	600·0	,,	1891, App. 44.
,, 4	,, ,,	Parkin	Fitzgerald.	,, ,,	820·0	,,	1891, App. 45.
,, 5	Kallara Holding, Moonooloo, 5th Well	Moonooloo.	Killara	,, ,,	900·0	,,	1891, App. 46.
,, 6	Kallara Holding, Box Bore, 6th Well.	....	,,	,, ,,	1,411·0	,,	1891, App. 47.
,, 7	Kallara Holding, Neefeenyah Bore, 6th Well.	Tutty	,,	,, ,,	540·0	,,	1891, App. 48.
,, 8	Kallara Holding, Paradise Bore, 8th Well.	Calpacaira.	,,	,, and Silurian ?	931·0	,,	1891, App. 49.
,, 9	Kallara Holding, Gum Lake, 9th Well	Paroo	,,	Post-Tertiary and Cretaceous.	676·0	,,	1891, App. 50.
,, 10	Kallara Holding, Tonga Bore, 10th Well.	Mulawoolka	,,	,, ,,	730·0	,,	1891, App. 51.
,, 11	Kallara Holding, Mungundi Lake Bore, 11th Well.	....	,,	,, ,,	760·0	,,	1891, App. 52.
Kerribree 1	Kerribree Holding.	....	Barrona	,, ,,	1,073·0	,,	1891, App. 38.
,, 2	,, ,,	....	,,	,, ,,	1,340·0	,,	1891, App. 39.
Leconfield 1	Leconfield Estate	Branxton,.	Northumberland.	Coal Measures	459·3	Coal	1884, pp. 150, 173.
,, 2	,, ,,	,,	,,	,, ...	96·7	,,	1884, p. 174.
,, 3	,, ,,	,,	,,	,, ...	70·1	,,	1884, p. 175.
,, 4	,, ,,	,,	,,	,, ...	616·0	,,	1884, p. 176. 1885, p. 156.
Lidsdale 1	Lidsdale, near Wallerawang.	....	Cook	Upper Coal Measures.	437·1	,,	1884, p. 184.
,, 2	" "	....	,, ...	,, ,,	355·1	,,	1884, p. 185.
Lochend	Lochend	....	Northumberland.	Newcastle, or Upper Coal Measures.	1,300·0	,,	1888, pp. 212–213. 1889, p. 144.
Long Swamp	Long Swamp, Marulan.	Marulan	Argyle	.....	702·11	,,	1883, p. 192.
Louth	Louth-Wanaaring Road, 26-mile post.	....	Landsborough.	Post-Tertiary and Cretaceous.	575·0	Water.	1891, App. 8.
L. T. Creek	L. T. Creek, near Lake Macquarie.	Awaba	Northumberland.	Newcastle, or Upper Coal Measures.	524·9	Coal	1883, p. 184.
Lucknow 1	Lucknow, Orange	....	Bathurst	Basalt and Alluvium	140·0	Gold	1885, p. 174.
,, 2	,, ,,	....	,,	Silurian, Serpentine, and Drift.	231·9	,,	1885, p. 175.
Maitland Gaol	East Maitland Gaol.	East Maitland.	Northumberland.	Tomago, or Middle Coal Measures.	745·9	Coal	1884, p. 179.
Marra 1	Marra Holding	Balara	Killara	Post-Tertiary, Cretaceous and Silurian ?	1,482·0	Water.	1891, App. 21.
,, 2	,, ,, ...	....	,, ...	Post-Tertiary and Cretaceous.	895·0	,,	1891, App. 22.
Milparinka 1	Milparinka	....	Evelyn	,, ,,	100·0	,,	1891, App. 19.
,, 2	106-mile post, Milparinka to Wanaaring Road.	....	Ularara	,, ,,	1,296·0	,,	1888, p. 228. 1889, p. 161. 1890, p. 175. 1891, p. 183. 1891, App. 4.
,, 3	121 Mile-post, Milparinka to Wanaaring Road.	....	,,	,, ,,	1,303·0	,,	1888, p. 229. 1889, p. 162. 1890, p. 177. 1891, p. 185. 1891, App. 5.
,, 4	91 Mile-post, Milparinka to Wanaaring Road.	....	,,	,, ,,	.....	,,	1888, p. 230. 1891, App. 16.
,, 11	Milparinka	....	Evelyn	,, ,,	218·2	,,	1888, p. 233. 1889, p. 164.
Mittagong	Mittagong	....	Camden	Upper Coal Measures.	657·6	Coal	1887, p. 190.
Momba 1	Momba Holding.	Charlton	Fitzgerald.	Post-Tertiary and Cretaceous ?	1,505·0	Water.	1891, App. 60.
,, 2	,,	Pachungi..	Yungnulgri	Post-Tertiary; Cretaceous; and Silurian ?	1,261·0	,,	1891, App. 61.

Name.	Locality.	Parish.	County.	Geological Formation.	Depth in Feet, &c.	Purpose	Reference.
Monk-Wearmouth 1	Monk-Wearmouth, Minmi.	Hexham ..	Northumberland.	Coal Measures	705·4	Coal ..	1885, p. 167.
,, 2	,,	,,	,,	,, ...	491·4	,, ..	1885, p. 168.
,, 3	,,	,,	,,	,, ...	657·6	,, ..	1885, p. 169.
Moongulla.....	Moongulla	....	Finch	Post-Tertiary and Cretaceous?	1,777·0	Water.	1891, App. 6.
Moongulla Reserve 1	,, ...	....	,, ...	,, ,,	326·0	,, ..	1885, p. 187. 1886 p. 196.
Moore Bank	Liverpool	Holsworthy	Cumberland.	Hawkesbury Series—Narrabeen Shales.	2,601·0	Coal ..	1889, .p. 148. 1890, p. 149.
Moschito Island.	Moschito Island....	Newcastle..	Northumberland.	Newcastle, or Upper Coal Measures.	617·1	,, ..	1883, p. 196.
Native Dog	Leila Springs.....	Leila	Gunderbooka.	Post-Tertiary and Cretaceous?	475·0	Water.	1891, App. 10.
New Lambton ..	Adamstown	Newcastle..	Northumberland.	Newcastle, or Upper Coal Measures.	243·1	Coal ..	1886, p. 190.
New Lambton Colliery Co.	New Lambton	Stowell....	Gloucester.	,, ,,	272·0	,, ..	1882, p. 124.
Nicoleche 1	Nicoleche Holding..	....	Barrona ..	Cretaceous?	916·0	Water.	1891, App. 29.
,, 2	,, ..	....	Ularara ..	Cretaceous and Granite.	1,500·0	,, ..	1891, App. 30.
,, 3	,, ..	....	Barrona ..	,, ,,	1,227·0	,, ..	1891, App. 31.
Nobby's.....	Newcastle	Newcastle..	Northumberland.	Newcastle, or Upper Coal Measures.	324·3	Coal ..	1891, Diag. 8.
North Shore....	North Shore	Willoughby	Cumberland	Hawkesbury Series ..	401·5	....	1885, p. 162.
Nowra	Nowra	....	St. Vincent	Upper Coal-Measures.	1,423·4	Coal ..	1890, p. 151.
Nyngan	Portion 71, Nyngan	Nyngan ..	Oxley	Post-Tertiary, Cretaceous.	520·6	Water.	1891, App. 7.
Outer Netallie ..	Outer Netallie, Wilcannia to Silverton-road.	....	....	,, ,,	83·0	,, ..	1884, p. 240.
,, A	,, ..	....	....	,, ,,	319·10	,, ..	1884, p. 241. 1885, p. 194.
Pelican Flat 1..	Pelican Flat, Lake Macquarie.	....	Northumberland.	Newcastle, or Upper Coal Measures.	1,000·1	Coal ..	1885, p. 177.
,, 2..	,, ..	....	,, ..	,, ,,	246·5	,, ..	1885, p. 178.
Penrith	Penrith	....	Cumberland	Hawkesbury Sandstone	434·3	,, ..	1885, p. 165.
Pirillie 1.....	Pirillie Holding....	....	Irrara	Post-Tertiary and Cretaceous.	613·0	Water.	1891, App. 41.
,, 2	,, ...	....	....	,, ,,	803·0	,, ..	1891, App. 59.
Port Waratah 1	Port Waratah.....	Newcastle..	Northumberland.	Newcastle, or Upper Coal Measures.	303·0	Coal ..	1885, p. 157.
,, 2	,, ...	,, ..	,, ..	,, ,,	141·0	,, ..	1885, p. 158.
,, 3	,, ...	,, ..	,, ..	,, ,,	273·2	,, ..	1885, p. 159.
Ravensworth 1..	Ravensworth	....	,, ..	Greta, or Lower Coal Measures.	990·9	,, ..	1889, p. 154. 1890, p. 165.
,, 2..	,, ...	....	,, ..	,, ,,	1,001·2	,, ..	1890, p. 167.
Redhead 1.....	Charlestown	Kahibah ..	,, ..	Newcastle, or Upper Coal Measures.	797·10	,, ..	1885, p. 170. 1886, p. 186.
,, 2.....	,, ...	,, ..	,, ..	,, ,,	935·7	,, ..	1886, p. 187.
,, 3.....	,, ...	,, ..	,, ..	,, ,,	357·0	,, ..	1887, p. 186. 1888, p. 211.
Rocky Mouth ..	Rocky Mouth, Clarence River.	....	Clarence ..	Clarence Coal Measures.	403·4	Coal ..	1885, p. 164.
Salisbury Downs. 1	Salisbury Downs Holding.	....	Tantara ..	Post-Tertiary and Cretaceous.	1,365·0	Water..	1891, App. 36.
,, 2	,, ,,	....	,, ..	,, ,,	1,568·0	,,	1891, App. 37.
South Redhead..	South Redhead	Kahibah ..	Northumberland.	Newcastle, or Upper Coal-measures.	895·0	Coal ..	1888, p. 149.
Snake's Creek ..	Snake's Creek, Charlestown.	Newcastle..	,,	,, ,,	997·6	,, ..	1888, p. 210.
Stanwell Park 1	Stanwell Park	Southend..	Cumberland	Hawkesbury Series; Upper Coal-measures	438·1	,, ..	1883, p. 181.
,, 2	,, ...	,,	,,	,, ,,	243·10	,, ..	1883, p. 182.
,, 3	,, ...	,,	,,	,, ,,	270·1	,, ..	1883, p. 183.
Stockton Coal Company.	Stockton	Stowell ..	Gloucester.	Newcastle, or Upper Coal-measures.	341·7	,, ..	1876, p. 140. 1882, p. 121–122
Stringer's Hill ..	Stringer's Hill	....	....	Post-Tertiary; Cretaceous,?and Silurian.?	248·2	Water	1890, p. 179.
Sunny Corner 1..	Sunny Corner	....	Mitchell ..	Silurian Sandstones and Slates.	401·0	Silver..	1886, p. 192. 1887, p. 192.
,, 2..	,, ...	....	,,	Silurian and Porphyry	657·0	,, ..	1887, p. 193.
Teralba	Teralba, Lake Macquarie.	Awaba	Northumberland.	Newcastle, or Upper Coal-measures.	568·0	Coal ..	1883, p. 185.
Tibbooburra 1..	Tibbooburra	....	Tongowaka	Post-Tertiary; Cretaceous; Silurian.?	288·0	Water	1888, p. 231. 1891, App. 17.
,, 2..	,, ...	....	,,	,, ,,	417·6	,,	1888, p. 232 1889, p. 163. 1890, p. 181. 1891, App. 18.

Name.	Locality.	Parish.	County.	Geological Formation.	Depth in Feet, &c.	Purpose	Reference.
Tulcumbah	Tulcumbah, near Carrol.	....	....	Post-Tertiary	264·0	Water..	1884, p. 239.
Wallarah	Wallarah	Wallarah ..	Northumberland.	Hawkesbury Series; Newcastle, or Upper Coal Measures.	286·10	Coal ..	1882, pp. 127-129.
Wangamana	Wangamana Holding	....	Barrona ..	Post-Tertiary and Cretaceous.	1,600·0	Water	1891, App. 40.
Waratah.....	Waratah	Newcastle	Northumberland.	Newcastle, or Upper Coal Measures.	1,127·6	Coal ..	1891, Diag. 6.
Waratah Coal Co. 1	Waratah Estate....	,,	,,	,, ,,	210·10	,, ..	1878, Sec. 10.
,, 2	John's Farm	,,	,,	,, ,,	153·8	,, ..	1878, Sec. 11.
,, 3	Waratah Estate....	,,	,,	,, ,,	148·7	,, ..	1878, Sec. 12.
,, 4	Waratah, near Loco. tank.	,,	,,	,, ,,	363·10	,, ..	1878, Sec. 14.
Weilmoningle 1..	Weilmoningle Holding.	....	Culgoa	Post-Tertiary and Cretaceous.	2,005·0	Water..	1891, App. 56.
,, 2..	,, ,,	....	,,	,, ,,	1,590·0	,, ..	1891, App. 57.
Werris Creek 1..	Werris Creek	....	Buckland ..	.....	672·0	,, ..	1885, p. 179.
,, 2 ..	,, ...	....	,,	.....	295·11	,, ..	1885, p. 180.
West Wallsend Co.	Wallsend	Teralba....	Northumberland.	Newcastle or Upper Coal Measures.	718·6	Coal ..	1883, pp. 137, 138
Wilcannia B....	C.R. 604, Wilcannia to Silverton road	....	....	Post-Tertiary and Cretaceous. ?	146·6	Water..	1885, p. 188.
,, C....	C.R. 605, Wilcannia to Silverton road	....	....	,, ,,	75·8	,, ..	1885, p. 189.
,, D....	C.R. 606, Wilcannia to Silverton road	....	....	,, ,,	....	,, ..	1885, p. 195.
,, E....	C.R. 607, Wilcannia to Silverton road	....	....	,, ,,	....	,, ..	1885, p. 190.
,, J....	64 Ml. W.R. Wilcannia to Silverton road.	....	....	,, ,,	210·9	,, ..	1885, p. 202.
,, K....	W.R. 545, Wilcannia to Silverton road	....	....	,, ,,	56·0	,, ..	1885, p. 201.
L....	C.R. 612, Wilcannia to Silverton road	....	....	Post-Tertiary, Slate and Granite.	89·9	,, ..	1884, p. 244. 1885, p. 200.
,, H....	Yancowinna Pls., Wilcannia to Silverton road.	....	....	Post-Tertiary and Cretaceous?	250·3	,, ..	1885, p. 203.
,, EE....	Glenlyon Station ..	....	....	,, ,,	229·2	,, ..	1886, p. 197.
,, CC....	Calker's Well	....	....	,, ,,	250·5	,, ..	1886, p. 198.
Woodford 1	Woodford	....	Cook.....	Hawkesbury Series; Upper Coal Measures.	1,658·6	Coal ..	1888, p. 214.
,, 2	,, ...	....	,, ...	,, ,,	1,394·8	,, ..	1888, p. 215. 1889, p. 146.
Wyee	Wyee	Wallarah ..	Northumberland.	,, ,,	946·8	,, ..	1890, p. 169. 1891, Diag. 12.
Wyong 1	Wyong	Munmorah	,,	Hawkesbury Series; Upper Coal Measures.	901·0	,, ..	1882, p. 129. 1883, p. 187.
,, 2	,, ...	,,	,,	,, ,,	897·0	,, ..	1882, pp. 129-130.
Yacaaba	Yacaaba	....	Gloucester	Coal Measures	675·0	,, ..	1892, p. 83: 1893, Diag. 3.
Yancannia 1....	Yancannia Holding	Cockulby ..	Yantara ..	Post-Tertiary and Cretaceous.	268·0	Water..	1891, App. 53.
,, 2....	,,	....	,, ..	,, ,,	303·0½	,, ..	1891, App. 54.
Yanda 1.....	Yanda Holding	....	Cowper ..	Post-Tertiary; Cretaceous; Silurian?	750·0	,, ..	1891, App. 34.
,, 2.....	,, S. 37° E., 10 mls. from Paroo River.	....	,, ..	,, ,,	1,008·0	,, ..	1891, App. 35.
Yantabulla	W.R. 162, Bourke to Hungerford Road.	Mucruss ..	Irrara	,, ,,	210·0	,, ..	1891, App. 11.
Youngarina	W.R. 159	Youngarina	,, ...	Post-Tertiary; Cretaceous?	165·0	,, ..	1891, App. 9.
Young Wallsend	Young Wallsend Mine.	....	Northumberland.	Newcastle, or Upper Coal Measures.	470·5	Coal ..	1886, p. 184.

XVIII.—On the Geological Structure of the Wyalong Gold-field: By E. F. PITTMAN, A.R.S.M., Government Geologist.

Situation.—The Wyalong gold-field is situated on the Wollongough Road, about forty miles in a north-westerly direction from the terminus of the railway at Temora.

Topographical and Geological features.—The country where the gold has been discovered consists of level plains covered with dense mallee scrub, and occasional belts of ironbark and box, while at long intervals are seen low ridges covered with cypress pine.

The surface of the plains consists, to a depth of two or three feet, of red and black clayey soils of Pleistocene age, with ironstone pebbles and occasional sub-angular fragments of quartz.

The pine ridges in the vicinity of the Government township of Wyalong are formed of hard rocks, consisting of hornblendic granite, diorite, and felsite, with slates, sandstones, and quartzites—the three latter probably of Upper Silurian age. The hornblendic granite, the diorite and the felsite appear in the form of intrusive dykes, which have burst through, tilted and transmuted the slates and sandstones, while the diorites and felsites have also intruded the granites. Some of the sedimentary rocks in the surveyed township are garnetiferous, and generally speaking, it may be said that the rocks over this area show great evidence of metamorphism. About two miles west of the main camp there is a low ridge upon which there is an outcrop of solid micaceous granite. A large lode of quartz with much tourmaline occurs here, and contiguous to it is a narrow belt of pure mica schist. There is another outcrop of solid micaceous granite about three and a half miles north of the main camp near the north-west corner of C.P. Portion 4—Gagie's Selection. In the granitic rocks hard white irregular shaped nodules of magnesite (carbonate of magnesia) are occasionally found.

Immediately underneath the two or three feet of Pleistocene clay which forms the surface of the plains decomposed granitic rocks occur; and herein is one of the most interesting features of the gold-field, for whereas the rocks forming the pine ridges are all of a very hard nature, the decomposed granitic rocks underlying the plains are so soft that no explosives are necessary for mining operations, and all the work of excavation has hitherto been easily done with the pick and shovel. These decomposed rocks are of various shades of grey, yellow, brown and red, and while some of them have evidently been micaceous granites, others are probably decomposed felsites and hornblendic granites, the brown or red colour being

caused by the peroxide of iron resulting from the decomposition of the hornblende. It is also probable that the felsites and hornblendic granites are of later age than the micaceous granite.

The decomposition of these granitic rocks over such a large area, and to a very considerable depth, is a matter of much interest. It may probably have been caused by oft-recurring inundation of the plains during Pleistocene times. The flood waters were probably never more than a foot or two in depth, so that the low ridges where the hard rocks still occur were not covered or affected; and as the surface of the granite on the plains became gradually softened by the action of the water and of the atmosphere, successive flood-waters carried down into it carbonic and other acids in solution, until the decomposition reached a considerable depth.

Mode of Occurrence and Character of the Reefs.—The reefs are found underneath the Pleistocene deposit, in the surface of the decomposed granitic rocks, where they generally appear as narrow threads, which widen out as they are followed down. Occasionally, however (as in Pettaford's Claim, Stanley's Blow, and others), they are found to be of considerable width at the surface; and, as a rule, they are then found to thin out, and eventually "make" or widen again as they descend. In fact, the reefs of this district are of the variety known as the lenticular reefs, such as are commonly met with in granitic rocks. The quartz has been deposited in fissures in the granitic rocks by the percolation of waters carrying silica in solution. The lens-like form which the reefs have in section is due to the fact that, when crystalline rocks such as granites are fractured, the resulting fissure follows a more or less *curved*, rather than a *straight*, line; and as the fracture is accompanied by a movement downwards of one of the walls, the resulting fissure will consist, not of a space between two planes, but of a series of more or less regular lens-shaped spaces. The formation of these reefs can be best illustrated by laying a sheet of paper on the table and drawing the point of a sharp knife across it in an undulating line, so as to separate it into two portions with curved edges. If one of the curved edges be then moved along the other, several lenticular spaces will be formed.

One of the characteristics of the Wyalong reefs, therefore, is that they "thin out" and "make" again at intervals, and this variation in width may be expected as a recurring feature in their *horizontal course*, as well as in their *downward extension*.

The general course of the reefs is about N. 20° E., and, as a rule, they have an easterly dip. In and around the main camp there appear to be at least eight approximately parallel lines of reef following this course. A few others, however, have a north-easterly course; while a few others again, such as the Pioneer, the Dead Rabbit, Bolte's Reef (on Bolte's Selection), Saunder's Reef, &c., strike about E. 23° N., and have a northerly dip.

Some of the reefs, notably those in Stanley's and Pettaford's Claims, are of solid white quartz, containing a considerable amount of mispickel (arsenical-iron pyrites), but, as a rule, they consist of more or less vesicular quartz, much stained with per-oxide of iron, and easily broken down with a hammer and gad.

Many of the principal reefs, such as these in Neild's Prospecting Claim (Mallee Bull Line), Gorman's Shaft, and others, are characterised by a considerable amount of black oxide of manganese.

Mispickel is of common occurrence in most of the reefs, and in Neild's Prospecting Shaft (Mallee Bull Line), small quantities of galena and iron pyrites were also seen. Gold can be seen in a considerable number of the reefs, it is mostly of a fine character, and has the appearance of having been set free by the decomposition of pyrites. In several of the reefs such as Bolte's, Conway's, &c., ironstone nodules occur; these nodules when broken in two are each seen to consist of a nucleus of mispickel (arsenical pyrites) surrounded by an envelope of limonite or brown iron ore (resulting from the decomposition of the mispickel) in which fine gold can be seen freely. In one instance the kernel of one of these ironstone nodules was found to consist of finely crystallised gypsum.

The greatest width observed on the field was in Neild's Prospecting Shaft (Mallee Bull Line) where, at a depth of thirty-five feet the reef has a thickness of about five feet for a short distance where a change of dip occurs. In Stanley's Blow the width of the reef at the bottom of the shaft is nearly four feet, and a similar width was observed in Gorman's Reef at a depth of ninety feet. In the latter case however, it was found that in a horizontal distance of about ten feet the reef had "pinched" to a few inches, while on the other side of this point it was "making" again rapidly.

Speaking generally the reefs may be said to vary in width from an inch or two to several feet.

Inclusions of country rock, known amongst miners as "horses", are of common occurrence in these reefs, and "faults" or "heaves" are also frequently met with.

There is one instance on the field of a reef occurring in a belt of slate. The reef referred to is situated rather more than a mile in a southerly direction from the surveyed township. The belt of slate is here very narrow (about twenty feet wide) and is bounded by dykes of diorite. In the prospector's claim this reef was fifteen inches wide, and showed good gold. In Doyle's Claim, adjoining the prospector's on the north, it had a width of only ten inches at a depth of six feet from the surface, but appeared to be very rich; while in No. 2 North (Gritten and Party) auriferous stone had also been struck—the reef appearing as a narrow thread, and widening out as it descended.

This belt of slate, or a parallel one, extends through the surveyed township of Wyalong, and is surrounded by intrusive rocks, which have separated it from the main body of sedimentary rocks, the western boundary of which may be seen four or five miles to the eastwards.

Outlying Discoveries.—During my visit a rush occurred at a place called the Nine-mile, in the parish of Hiawatha, County of Gipps, about nine miles in a north-eastern direction from the main camp at Wyalong. Several reefs were discovered here, but very little work had been done upon them. One of these reefs (Gagie's Claim) showed good gold, but was cut off by a "fault," and they are now driving with the object of recovering the lost or "heaved" portion of the reef. This reef was also characterised by the occurrence of the nodules of limonite containing kernels of mispickel, which have already been described. The reefs at the Nine-mile Rush occur close to the junction of the main body of sedimentary rocks (just referred to), with decomposed granitic rocks similar to those at Wyalong. Gagie's Reef, and several others, are in the latter formation, but other reefs have also been found in the slate. A small patch of Tertiary drift (probably Pliocene), consisting of well-rounded pebbles of metamorphosed rocks, occurs on the side of a small ridge, at the Nine-mile Rush.

On Lange's Selection—Portion 11, Parish of Wyalong—about four miles north-west of the main camp, a vertical reef, having a width of four feet, has also been discovered in similar decomposed granitic rocks. I was informed by the owners, West and Party, that specimens showing gold had been taken down to Sydney from this reef, but on the occasion of my visit I could not see any. Comparatively little work has been done on this reef pending the granting of a permit to mine.

About two miles north-east of the surveyed township of Wyalong, a reef (the Little Darling) has been discovered by Barker and Party. This reef was six inches wide just beneath the surface, and showed good prospects. Here again, and for a further distance of at least two miles eastwards, the country consists of the same decomposed granitic rocks covered by Pleistocene clays.

About two miles to the south of Wyalong on George Bolte's Conditional Lease, Portion 21, Parish of Wyalong, is another reef showing good gold. This reef, which is being worked in the prospecting claim, by Bolte and Party, bears east 20° north, and dips north 20° west at an angle of about 44°. It is nearly three feet wide in places, and prospects well. The formation in which it occurs is again the same decomposed granitic rock.

Extent of Auriferous Area already prospected.—It will thus be seen that the area in which auriferous reefs have already been proved to exist in the same soft rock, extends for at least seven miles in a north and south direction, by a similar distance east and west. Only the central portion of this area—or about one square

mile—has been anything like systematically prospected; while the outlying discoveries, such as the Little Darling Reef on the extreme east, the Nine-mile Rush to the north-east, West and Party's reef on Lange's Selection to the north-west, and Bolte's Reef on Portion 21 to the south, appear to point to the probability of many other auriferous reefs existing within the area bounded by them.

Difficulties in the way of prospecting.—The outlying reefs just described must not be regarded as the ascertained boundaries of the gold-bearing area, but merely as the extreme limits to which prospecting had been carried at the time of my visit. The extremely level nature of the country, and the occurrence of continuous surface covering of Pleistocene clays, renders it a very difficult matter to define the limits of the auriferous area. In fact, it is only by digging costeaning trenches, or sinking shafts that the presence of reefs can be discovered; and hence it is that prospecting on this field becomes purely a matter of patient and careful work—there being little or no surface evidence to guide the miner.

Credit is undoubtedly due to the Neild family for the manner in which they have developed the field. They came there without any experience in mining and their success must be entirely attributed to their industry and determination. The method followed by them was to break and examine any fragment of quartz which they saw on the surface, and whenever they saw colours of gold in the stone, they sank through the two or three feet of clay or soil. In most instances they succeeded in finding the reef immediately below, and in this manner they have become the owners of some of the most promising reefs at Wyalong. Their example might be most advantageously followed by many men whom I saw on the field.

Conditions of Mining.—It has already been stated that with one exception (viz. where an auriferous reef occurs in slate country) the Wyalong reefs are found in decomposed granitic rocks, and these are so soft that no explosives are required for mining purposes. In addition to being very easily excavated, this decomposed rock appears to "hold" fairly well, or in other words, does not require a very great amount of support in the shape of timbering. It is evident, therefore, that at present the reefs are being worked under the most favourable conditions for economical mining.

The question as to the limit in depth to which these decomposed rocks may be expected to extend is one of considerable interest, as it will influence, in no small degree, the future of the field. In Taylor's Shaft, which at the time of my visit, had reached the depth of one hundred and seven feet, no perceptible difference could be observed in the character of the country rock, nor had the reef shown any alterations worthy of note, beyond the variations in width, which have already been alluded to as characteristics of all the reefs on the field. Moreover I was informed that in a shaft which had been sunk on a selection, four or five

miles distant from Wyalong, a depth of one hundred and ninety-two feet had been attained without striking water, and without getting below the limits of the decomposed granitic rocks. It may fairly be assumed, therefore, that the same favourable conditions as those under which the reefs are at present worked, will obtain to a depth of about two hundred feet. But on the other hand, there can be little doubt that the decomposed rock will eventually give place to hard granite, and when this is reached the cost of excavation will be a very much more expensive matter. In addition to this, when the hard rock is reached, it is probable that water will be met with to some extent, and the gold will be found (partly at any rate) in a more or less complex ore. Much of the gold showing at present has the appearance of having been set free by the decomposition of pyrites, and therefore it is fair to assume that below the water level, roasting and chlorination, or some analogous process will be required for its extraction from the sulphurous ores.

Possibility of Alluvial Deposits being found.—Mention has already been made of the level nature of the country at Wyalong and the covering up of its geological features by a uniform deposit of Pleistocene clays. Owing to these conditions, the discovery of old river valleys or alluvial deposits, is rendered even more difficult than the discovery of new reefs. Judging by the shafts already sunk, the bed-rock appears to come within a nearly uniform distance of the surface around the main camp, and there does not seem to be a very good prospect of alluvial drifts being discovered in the immediate vicinity. The field is, however, about eight hundred feet above sea level, and there is every reason, therefore, to expect that in Tertiary times the drainage from this area found its way into deep valleys, and deposited therein the gold which was derived from the denudation of the reefs. The search for these old valleys will probably require time and patience, but in the meanwhile it appears to me that one of the most likely looking outlets, viz., between the 16-Mile Tank and Doyle's Claim (south of the surveyed township), has been scarcely prospected.

Source of the Gold.—There is, I think, little doubt that the hornblendic rocks may be regarded as the immediate source of the gold at Wyalong. The hornblendic granites as well as the diorites, are probably of later age than the micaceous granites and sedimentary rocks which they have burst through in the form of dykes. These eruptive rocks when in a molten condition, probably carried a small proportion of gold from great depths, and it was subsequently leached from them and deposited in the reefs by the gradual percolation of thermal waters. The occurrence of such hornblendic rocks in proximity to gold-bearing reefs is characteristic of New South Wales gold-fields.

Up to the present date four hundred and eighty-eight tons of stone from Wyalong have been crushed for a total yield of eight hundred and sixty-nine ounces of smelted gold.

Summary.—In conclusion I may state that while the Wyalong reefs may all be expected to vary considerably in width, I can see no reason why they should not be persistent in depth. On the other hand at a depth of two hundred feet or thereabouts, the decomposed rocks in which the reefs are now being worked may be expected to give place to solid granite, and it is obvious that the cost of mining will then be materially increased, while the gold will probably be more difficult to extract.

In the meanwhile a considerable number of reefs have been proved to contain gold which should certainly be payable while the present conditions of mining obtain, and there seems to be every reason to suppose that the auriferous area will be considerably extended.

Preparations were being made for the erection of three batteries at Wyalong, when I left the field.

10th May, 1894.

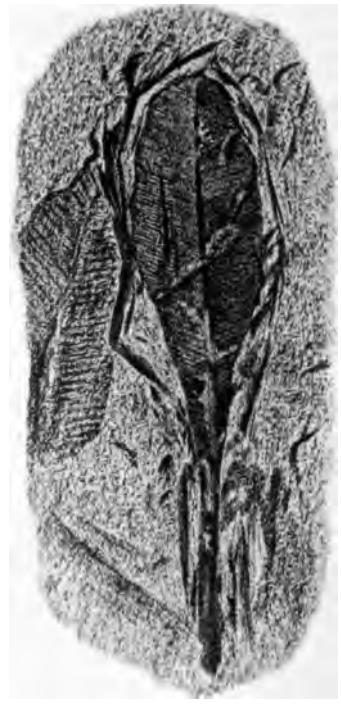
PLATE VIII.

Oleandridium lentriculiforme, *Eth. fil.*

Fig. 1. An entire leaf, from Gosford.
Fig. 2. An incomplete leaf, from Freshwater.
Fig. 3. Portion of the neuration, magnified twice.

Drawn from nature by Mr. P. T. Hammond.

1



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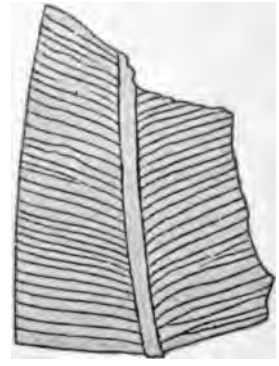


3

P. T. Hammond. del.

Heliotype.

PLATE IX.

Fig. 1. Iguana, 3 feet 7 inches long.

Fig. 2. Imperfect outline, perhaps intended for a human figure, with bird-like head, &c.

Fig. 3. Possibly intended for a "Flying-fox" (*Pteropus*), or an Eagle-hawk, 3 feet 6 inches.

Fig. 4. Human leg, possibly the left, 2 feet.

Fig. 5. Female figure with upraised arms, but minus the feet; above the head is a heart-shaped body, 3 feet 5 inches.

Fig. 6. Emu, somewhat bent forward, 6 feet.

Fig. 7. Small bird possibly, of irregular proportions.

Fig. 8. Emu, smaller than Fig. 6, and in a more upright position, 3 feet 10 inches.

Fig. 9. Flying-squirrel (*Petaurus*), 2 feet 4 inches.

Fig. 10. Opossum probably, 4 feet 6 inches.

Fig. 11. Dilly-basket, 3 feet 9 inches.

Fig. 12. Echidna, 1 foot 6 inches.

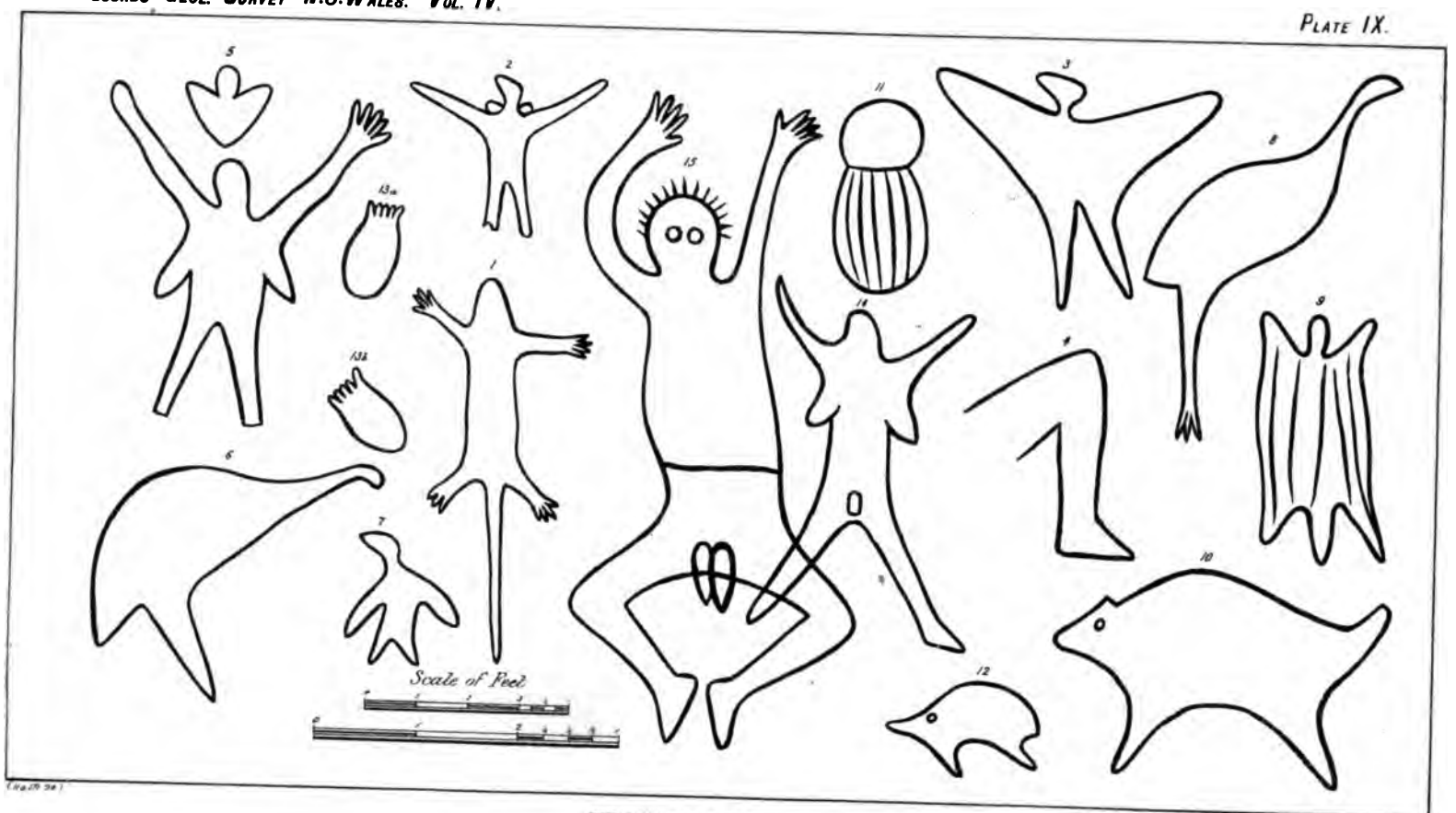
Fig. 13*a* and *b*. Foot-prints—Two of three impressions, 1 foot.

Fig. 14. Female figure, close to that of the male Fig. 15, 3 feet 6 inches.

Fig. 15. Male figure in the attitude of one of the magic dances, with head-dress, 6 feet 2 inches.

Drawn to scale, from nature, by Mr. G. H. Barrow.

PLATE IX.



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DEPARTMENT OF MINES AND AGRICULTURE, SYDNEY.

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Vol. IV.] 1895. [Part III.

XIX.—On a Trachytic Rock from the Coonabarabran District: by GEORGE W. CARD, A.R.S.M., F.G.S., Curator and Mineralogist.

[Plate X.]

EARLY in the latter half of 1893 a collection of specimens from the neighbourhood of the Warrumbungle Mountains was submitted for examination by Mr. W. L. R. Gipps, of Bearbong, Gilgandra. The collection included various forms of hemi-crystalline silica, tripolite, a number of very perfect fresh crystals of felspar, and some pieces of a very compact cream-coloured rock that superficially bore some resemblance to quartzite, but were found on closer inspection to exhibit a vast number of rectangular crystal-faces, to contain small porphyritic crystals of sanidine, and to be readily scratched with a knife. A thin section was prepared, when it was at once evident that, so far as regards its constitution, the rock was typically trachyte. Various inquiries have been made with a view to obtaining information as to the mode of occurrence of the rock, and further investigation was delayed in the hope of an opportunity occurring of personally examining it in the field. It does not, however, seem advisable, considering the interest attaching to all occurrences of trachyte—one of the less common eruptive rocks—and to this in particular as being apparently the first recorded occurrence of true trachyte in New South Wales, to any longer postpone the preliminary description of the rock.

Stratigraphical Relations.—The whole of the specimens referred to are given by Mr. Gipps as coming from the cuttings of the Wantialable Creek, Parish of Urombong, County of Gowen. In the recently published Geological Map of the

Colony* this area is coloured as being occupied by the Tomago beds of the Permo-Carboniferous Formation, with a patch of Hawkesbury beds at Coonabarabran, and several areas of basic igneous rocks in the neighbourhood.

From a sketch, kindly supplied by Mr. Gipps, it would seem that the tripolite—a variety containing sponge spicules—occurs at the base of the cutting. This is overlaid by a fragmental rock which is succeeded by a bed of soft yellowish material in which the numerous felspar crystals referred to above occur; the rock now under consideration forming the surface. A few of these felspar crystals have been examined by Czabo's method by Mr. James Taylor, B.Sc., A.R.S.M., who kindly informs me that he regards them as containing a relatively high proportion of soda, and that, from this reason, as well as their somewhat low fusibility, they might perhaps be regarded as soda-orthoclase. The crystals are beautifully clear, and frequently have their crystalline form very well developed. From the information to hand it is not clear whether there is any connection between the deposit containing these crystals and the overlying trachytic rock.

General Description.—Whitish in colour with a tendency to grey or smoky. Fracture even to sub-conchoidal, breaking with sharp corners; translucent at the edges. Here and there imperfect natural divisional planes occur. With some difficulty it can be scratched with a knife, giving a white streak. Embedded in the matrix, which is compact and homogeneous, are very minute lath-shaped crystals, exhibiting glancing faces, with here and there a larger tabular crystal. In thin section, under the microscope, many of these are seen to be *Sanidine*. *Quartz* is very rare.

The *specific gravity*, as determined by various methods is well under 2·4, the results obtained differing somewhat. This is a low density even for a normal trachyte-glass. From the abundance of crystals contained in the glass a density somewhat above the average† might have been expected. On the other hand, it will be seen from the analysis given below that there is a total absence of heavy bases, such as iron; also, that a large amount of amorphous secondary silica is present. An analysis by the Assayer and Analyst, Mr. J. C. H. Mingaye, F.C.S., resulted as follows:—

Moisture at 100° C.	2·22
Combined water	2·17
Silica (SiO_2)	74·12
Alumina (Al_2O_3)	12·39
Ferrous oxide (FeO)	·21
Ferric oxide (Fe_2O_3)	·31
Manganous oxide (MnO)	trace.
Lime (CaO)	·30
Magnesia (MgO)	·42
Potash (K_2O)	5·07
Soda (Na_2O)	3·22
Sulphuric anhydride (SO_3)	trace.
Phosphoric anhydride (P_2O_5)	trace.
	100·33

* Geol. Survey N. S. Wales, Department of Mines and Agriculture N. S. Wales, 1893.
† 2·4.

This analysis approximates very closely to that of an average granite or felsite. To a certain extent, at any rate, the high percentage of silica is due to its presence in secondary amorphous form, of which a considerable amount can be detected under the microscope. The percentage of soda and potash is quite normal, while the disproportion between the silica and the alumina may be partially explained by the presence of the secondary free silica. The practical absence of iron, lime, and magnesia, leaves the rock a very pure silicate of potash and soda with free amorphous silica. The chemical composition of the felspar has not been determined, but from the analysis, it would seem probable that soda-orthoclase or even oligoclase are present, as they generally are, in rocks of this class.

Microscopic Characters.—[Slide 444.]—Under the microscope in thin section the rock is seen to consist of a vast number of perfectly fresh and well-formed crystals of untwinned or simply twinned felspar embedded in a greyish matrix which is resolved by a high power into a granular colourless glass containing very many microlites of felspar. Two distinct sets of felspar crystals are present. The one consists of a multitude of lath-shaped individuals, sometimes seen in cross-section, averaging perhaps ·15 mm. in length; these are generally simply twinned, and are arranged in groups each having a general trend in an approximately fixed direction. Occasionally a bent or broken individual is seen. Sometimes (*see* Pl. X) they flow round the porphyritic constituents, and were evidently in existence while the rock was still in a viscous condition. The other set includes porphyritic more or less tabular individuals and aggregates of very clear and frequently idiomorphic felspar. These are all untwinned, but the polarisation effects are very irregular, indicating conditions of molecular strain. They have been somewhat corroded by the magma, the corrosion sometimes (*see* plate) acting most energetically along certain crystallographic planes, giving rise to a somewhat stepped structure. A good deal of glass is included in one of the aggregates. In many of the medium-sized individuals, more especially, the crystal-edges are completely obliterated by interaction between the felspar-substance and that of the matrix; the zone of interaction sometimes exhibiting a reddish tinge.

A considerable quantity of a clear, slightly polarising substance, with irregular outlines and a concentric arrangement, is present. There can be little doubt that this is silica, and the high percentage of that element given by analysis can be explained by its presence, as can also, perhaps, the compact texture and rather low specific gravity of the rock.

The only other constituent is represented by a few specks of a green and brown pleochroic mineral.

XX.—Notes on the Occurrence of Monotreme Remains in the Pliocene of New South Wales: by W. S. DUN, Assistant Palæontologist and Librarian.

[Plates XI and XII.]

I.—Introduction.

THE living representatives of the Monotremata are, perhaps, the most interesting forms of the peculiarly characteristic elements of the Australian mammalian fauna, embodying as they do both reptilian and marsupial characters. On this account the occurrence of remains representing new species of a gigantic *Echidna*, and also of an *Ornithorhynchus* in the Pliocene of the Canadian Lead, Gulgong, will form very welcome additions to our Tertiary Mammalian Fauna. The discovery of our specimens was announced by the late Mr. C. S. Wilkinson in 1886* as having been found by Mr. William Thew in the gold-bearing wash in a limestone cavern, at a depth of one hundred and thirty feet. He states that Dr. E. P. Ramsay identified, in the same collection, remains of *Megalania*, •kangaroo, and birds. As far as previous records of fossil Monotremes in Australia are concerned, the late Mr. Gerard Krefft, in a letter† to the "Annals and Magazine of Natural History" in 1868, drew attention to remains of the articular head of a humerus of an extinct *Echidna* from the Pleistocene deposits of Queensland. To this form he gave the tentative name of *Echidna Oweni*. His letter was accompanied by drawings. In 1884 the late Sir Richard Owen described‡ the left humerus of an *Echidna* from the Wellington Caves Bone-deposits. This form Sir Richard described as *E. Ramsayi*. Mr. R. Lydekker has pointed out in the B.M. Catalogue of Fossil Mammals§ that as the specimens seem to agree very closely, Krefft's species, *Echidna Oweni*, made in 1868, will have to be given priority, so that the form will be known as *E. Oweni*, Krefft. Mr. Lydekker also includes, for Palæontological purposes, the New Guinea genus *Proechidna* with *Echidna*. Whilst giving these few notes on the history of the fossils specimens of *Echidna*, attention should be drawn to a remark made by the late Mr. Gerard Krefft in his "Report on the Exploration of the Wellington Caves" with the late Professor A. M. Thompson of the Sydney University.‖ This report was made to the Colonial Secretary (the late Sir John Robertson), in 1870, but was not published till 1882. He says:—"Order Monotremata. Of the two singular genera belonging to this strictly Australian order, very few remains have been discovered, and none as yet of the *Ornithorhynchus*. The Echidna or ant-eater has been observed before, and is

* Ann. Rept. Dept. Mines N. S. Wales for 1886 [1887], p. 138.
† Ann. & Mag. Nat. Hist., 1868, I (4), pp. 113-114.
‡ Phil. Trans. R. Soc., 1884, Pt. I, pp. 273-275, pl. 14.
§ Vol. V, pp. 295-296.
‖ Exploration of the Caves and Rivers of New South Wales (Minutes, Reports, Correspondence, Accounts). *N.S. Wales Parl. Papers*, 1882, 162—A, pp. 52, plates, &c. (Folio, Sydney. By Authority), p. 11.

represented by a fossil arm-bone from Queensland. [Evidently refering to the bone mentioned in the Ann. and Mag. Nat. Hist.] The caves of Wellington yielded a fractured femur of a species larger than our present *Echidna hystrix*."

In 1885 Mr. C. W. de Vis, M.A., Curator of the Queensland Museum, announced the first discovery of remains of *Ornithorhynchus* in Australian Post-Tertiary deposits, and described* the right tibia and mandible of an *Ornithorhynchus* from Post-Tertiary deposits at King's Creek, near Pilton, Q.—this he named *O. agilis*. This species, as pointed out by Mr. de Vis, is very remarkable from its small size, and as a contrast to this, it is extremely interesting to find so large a species as *O. maximus* occurring in the Pliocene at the Canadian Lead. In the same paper he mentions a claw-bone at present in the Brisbane Museum as probably referable to *E. Oweni*, Krefft. From these few remarks it will be seen that extinct Monotreme remains are very scarce, those at present known to me as occurring in Australian collections being:—

Ornithorhynchus agilis, *de Vis.*

1. Right tibia and mandible. King's Creek, near Pilton, Q.; Post-Tertiary. Type in the Queensland Museum, Brisbane.

Ornithorhynchus maximus, *Dun.*

2. Right humerus. Canadian Lead, Gulgong; Pliocene. Type in the Mining and Geological Museum, Sydney.

Echidna (Proechidna) Oweni, *Krefft.*

3. Clawbone. Queensland; Post-Tertiary. In the Queensland Museum, Brisbane.
4. Articular head of humerus. Darling Downs, Q.; Post-Tertiary. Type in the Australian Museum, Sydney. This is the specimen figured by Krefft in the "Annals and Magazine of Natural History."
5. Left humerus. Wellington Caves; Post-Tertiary. Type in the Australian Museum, Sydney. This is the specimen figured by the late Sir Richard Owen in the Phil. Trans., 1884, as *E. Ramsayi*.
6. Scapula and portion of interclavicle or episternum. Wellington Caves; Post-Tertiary. Australian Museum, Sydney.
7. Portion of a femur. Wellington Caves; Post-Tertiary. Australian Museum, Sydney.
8. Clawbone. Wellington Caves; Post-Tertiary. Mining and Geological Museum, Sydney.

Echidna (Proechidna) robusta, *Dun.*

9. Portion of skull and atlas vertebra. Canadian Lead, Gulgong; Pliocene. Type in the Mining and Geological Museum, Sydney.

* Procs. R. Soc. Queensland, 1885, II, pp. 35-38, pl. 6.

II.—Geology.

The Geology of the Gulgong District, and the relations of the Deep Leads, have been described by the late Mr. C. S. Wilkinson *. The town of Gulgong is situated on a range "composed of granites and Upper Silurian conglomerates, schists and limestones, intruded by large masses and dykes of greenstone diorite." It is on the flanks, and at the bases of this range that the leads occur. These leads have yielded almost the whole of the gold obtained in the district. The chief leads here are Adams' Lead, Black Lead, Moonlight Lead, and the Happy Valley Lead. The Canadian Diggings are situated four and a half miles south-east of Gulgong, and here several leads are united to form the Canadian Lead, which runs to Home Rule. There is a considerable tract of basalt around Gulgong, which in many places covered over the wash in the old drainage channels. In another report Mr. Wilkinson gives a much more detailed account of the Canadian Lead, and I may, perhaps, be excused for quoting it in its entirety, as it is practically the only account we have. He says, "A very remarkable feature in connection with the deep lead is the deposit of auriferous wash in limestone caverns at the Canadian. Here some massive beds of marble limestone occur, and in the tertiary pliocene period contained caves into which the ancient river drained, just as the streams do at the present day at the Jenolan Caves and elsewhere. At length these old caves became filled up with the gold-bearing gravel and silt, and the valley also, to a level of about eighty feet above that of the caves. At the White Horse claim, which is under the able management of Mr. Thompson, a shaft has been sunk below the level of the old river-bed or lead, and into the cave deposit, to a depth of two hundred feet and thirty six from the surface, without reaching the bottom of the cave. In one part the cave is oblong, measuring one hundred and ten feet by forty-three feet, and funnel-shaped, diminishing in size downwards, with uneven walls, and smaller caves leading into it It is filled with a stiff ferruginous clay, called by the miners 'pug,' and occasional floors or layers of wash, with limestone boulders, and a little quartz. * * * A similar cavern deposit has been worked in the Canadian prospecting claim, which is situated about half a mile S.S.E. from the White Horse claim." In another place, speaking about the flow of the basalt in the old drainage channel, Mr. Wilkinson says, † "I say some of them; for whereas a large stream descended from the mountains on the east, flowing in the Cooyal Creek Valley, near Gulgong, thence into the Cudgegong Valley, covering up the river channels of the pliocene period, the upper part of the Cooyal Valley, where the Home Rule and Canadian leads occur, escaped this flood of molten lava." Professor David likewise considers that these lavas are of Pliocene age, and that they are probably homotaxial with the Pliocene lavas of Victoria. ‡

* Ann. Rept. Dept. Mines N. S. Wales for 1876 [1877], pp. 166-174; *Ibid.* for 1886 [1887], pp. 134-139.

† *Ibid*, p. 130.

‡ Proc. Austr. Assoc. Adv. Sci., 1894, V., p. 402. See also Clarke, Fed. Form. N. S. Wales, 4th Ed., 1878, pp. 89, 93, 106, for remarks on the Geology of this District.

Remains of a fairly abundant flora have already been collected from these Gulgong Deep Leads, and have been described by Baron F. v. Mueller.* They comprise the following genera and species:—

Phymatocaryon bivalve, *F. v. M.*
„ McKayi, *F. v. M.*
„ „ *var* quinquevalvis, *F. v. M.*
„ angulare, *F. v. M.*
„ „ *var.* elongata, *F. v. M.*
Wilkinsonia bilaminata, *F. v. M.*
Illicites astrocarpa, *F. v. M.*
Pentacoila gulgongensis, *F. v. M.*
Pleiacron elachocarpum, *F. v. M.*
Ochthodocaryon Wilkinsonii, *F. v. M.*
Plesiocapparis leptocelyphus, *F. v. M.*
Acrocoila anodonta, *F. v. M.*
Spondylostrobus Smythii, var. cryptaxis, *F. v. M.*
Eisothecaryon semiseptatum, *F. v. M.*

Mr. R. Etheridge, Junr., has recorded the occurrence of a *Unio, U. aucklandicus*, var. *Wilkinsoni*, Eth. fil., in the lead at Home Rule.† Among the Vertebrates remains of *Meiolania platyceps*, Owen, and a turtle allied to *Chelodina sulcifera*, Gray, have been recorded by the same Author.‡ From the Magpie Lead, Mr. Wilkinson§ reported finding remains of *Diprotodon*, *Halmaturus* and *Macropus*, while he records as before mentioned from the Canadian Lead remains of *Meiolania* [*Megalania*], *Macropus*, *Echidna*, and birds. To this fauna of the leads may now be added *Echidna* (*Proechidna*) *robusta*, Dun, and *Ornithorhynchus maximus*, Dun.

III.—Description.

Echidna (Proechidna) robusta, *sp. nov.*

Skull.—The portion of the skull that is preserved consists of the upper part of the cranium, the remains of the occipitals and about half of the rostrum, of which unfortunately not enough remains to show the premaxillaries. In common with recent adult Monotreme skulls this specimen shows very little, and in most instances, no traces of sutural connection between the bones of the skull. Taking into consideration, first, the general contour of the skull, it will be seen, apart from the great difference in size, that the frontal curve more nearly approaches that of *Proechidna* than *Echidna*. In *Echidna hystrix*, var. *aculeata* the angle is fairly steep, curving off gradually into the prolongation of the rostrum, which in

* Ann. Rept. Dept. Mines N. S. Wales for 1876, [1877], pp. 178-180; *Ibid* for 1878 [1879], pp. 169-172, pls. 3 and 4.
† *Ibid* for 1878 [1879], pp. 164-169, pl. 3, fig. 5.
‡ Records Geol. Survey N. S. Wales, 1889, I, Pt. 3, pp. 149-152, pls. 25, 26.
§ Ann. Rept. Dept. Mines N. S. Wales for 1876 [1877], p. 172.

its entirety is curved slightly upwards; in *Proechidna* the angle is not only less steep, but the curve is less marked, and in some cases almost absent, while the rostrum is curved downwards to a very well marked and constant degree. In *E. robusta* the frontal angle is about the same as in *Proechidna*, curving very gently to the rostrum, which, if perfect, would probably show a slight downward curve. The breadth of the palate at the foot of the zygomatic arches is twenty-two mm. as compared with a similar measurement of sixteen mm. given by a skull of *Proechidna Bruijnii*. The palate is much more concave than in *Proechidna*, and the thickness of the rostrum at the same place is in the ratio of sixteen mm.; thirteen mm. From a comparison of these measurements with those of a cast of a skull of *Proechidna* in the Departmental Collection, an approximate basal length, that is, a length from the foramen magnum to the gnathion or anterior point of the premaxilla, of two hundred and sixty-five mm. is obtained for our specimen. Such a measurement is decidedly only approximate, and no doubt would be much more valuable were there more skulls of *Proechidna* available for comparison; but it may be of some use as giving a rough idea of the length of skull of this ancient *Echidna*. Mr. Oldfield Thomas in his Catalogue of Marsupials and Monotremes* gives the basal length of the skull of an adult male *Proechidna Bruijnii* as one hundred and fifty-six mm., whereas the measurements of an adult female specimen are given by him as one hundred and eighty-two mm. According to this, if any value at all can be placed on the comparison, the skull of *Echidna robusta* may be assumed to be half as long again as that of *Proechidna Bruijnii*. As in *Proechidna* the lateral borders of the palate are much elevated giving a great concavity to the rostrum. From what remains of the inner part of the cranium it may be seen that the surface of the brain is more convoluted than is the case in *Echidna*, agreeing in this respect with *Proechidna* as pointed out by Gervais in his "Osteographie des Monotremes," in which he remarks "La boîte cérébrale est en méme temps plus ample [than in *Echidna*] et le moule de sa cavité interieure montre qu'il existe une plus grande complication des circonvolutions propres aux hemispheres cerebraux."† The broken portion of the rostrum shows the nasal passages with a thick nasal septum.

Pl. XII, Figs. 3 and 5 show what remains of the occipital region of *P. robusta*. They show portion of the basi-occipital and the occipitals, with their well-marked condyles for articulation with the atlas vertebra. In Pl. XII, Fig. 4 is seen the upper triangular portion of the very large foramen magnum bordered by the ex-occipitals. The right-hand portion of the supra-occipital is present in part, but in common with the other bones of the cranium owing to the indistinctness of sutural junctions nothing can be made out of its outlines. Portion of the parietal, and the frontal and nasals in part, are preserved. Part of the right alisphenoid and of the orbito-sphenoid are also to be seen. The anterior portion of

* Brit. Mus. Cat. Marsupials and Monotremes, 1888, p. 384.
† Ostéographie des Monotremes vivants et fossiles, p. 46.

the styliform zygomatic arch is preserved, with the malar articulating with the maxillary. On the inner side of this arch is a very well marked foramen running forwards; and in front of it is a well marked groove running forwards and upwards. All these portions, as far as can be made out from the little that remains, are very similar to similar regions in *Proechidna*.

The atlas vertebra (Pl. XI, Figs. 4 and 5) is almost perfectly preserved, the portions wanting being the neural spine and the transverse processes. On the anterior aspect will be seen the well marked anterior zygapophyses for articulation with the occipital condyles. These are large, well hollowed, ear-shaped, and more nearly approaching in general form the corresponding parts of *Proechidna Bruijnii* than its much smaller ally *Echidna aculeata*. The posterior zygapophyses are narrower, less hollowed than the anterior, the curve of the inner margin is more regular, there being no lower lobe—as is the case in the anterior zygapophysis—the articular surface merging gradually into the inferior arch. The transverse processes have been broken off near their bases, but allowing for the difference in size, the basal portions do not show any difference, beyond perhaps a slightly more marked hollowing at the upper border, from those of *E aculeata*. The neural arch is much thicker and more developed than in either *Echidna* or *Proechidna*; it is divided into two well-marked surfaces, that directed forwards and bearing the neural spine or tubercle, and that sloping posteriorly. This neural spine seems to be very differently constituted than is the case in *Proechidna Bruijnii* or *Echidna aculeata*. Unfortunately I have not been able to obtain specimens of this bone of *Proechidna* for examination, but judging by the figure given by Gervais* there would seem to be only a small tubercle developed, less marked than is the case in *Echidna aculeata*. This anterior slope has a width of 10·5 mm., and the neural tubercle, of which unfortunately only the base remains, has its origin along the entire width of the slope and a thickness at the base of five mm. In *Echidna aculeata*, var. *hystrix*, the corresponding tubercle seems to be developed in a somewhat different manner, and instead of being laterally flattened its width is much greater than its thickness and is practically in the same plane as the posterior slope of the neural arch.

These vertebral and cranial remains seem to show a greater resemblance to *Proechidna* than *Echidna*, though it must not be overlooked, as has already been pointed out by Mr. O. Thomas† that it is by no means certain that these two are generically separate. On account of its size it is proposed to record it as *Echidna* (*Proechidna*) *robusta*.

IV.—Ornithorhynchus maximus, *sp. nov.*

The right humerus (Pl. XI, Figs. 1–1) that is taken to represent this species, is undoubtedly referable to a gigantic species of *Ornithorhynchus*, which it is proposed to name *O. maximus*, on account of its great size. The most striking

* Ostéographie des Monotremes vivants et fossiles. Atlas, Pl. 8, figs. 1. and 1a.
† *Loc. cit.* p. 383.

point in it is its great size, there being but few differences apart from that between it and the corresponding bone in the recent *O. anatinus*. The length from the uppermost surface of the ectotuberosity (great) to the process is eighty-four millimetres; the breadth across the head, between the ento-(lesser) and the ecto-(greater) tuberosities is forty-four millimetres; the width of the shaft just above where the distal expansion begins is twenty-five millimetres, and the width between the entepicondyle (internal) and the ectepicondyle (external) is seventy-two millimetres. The humerus may be considered to be made up of three well-marked surfaces; (1) of the antero-internal, which at the proximal end bears the articular head, and the bicipital groove, is bordered laterally by the internal and anterior borders, and distally is continued to the internal condyle; (2) the antero-external, which on the front view consists of the slope that is continued into the external condyle and is laterally continued up to the deltoid ridge; and (3) the posterior surface. Taking first into consideration the articular head, this seems to be more sharply marked off from the body than in the recent species, and as will be seen in Pl. XI, Fig. 3, the general outline of the surface is very similar The bicipital groove is very well-marked, but the border of the great tuberosity does not overhang it to the same extent as in *O. anatinus*. Going further down the shaft the surface is seen to be practically smooth, showing below the distal border of the bicipital groove a well-marked scar of attachment for the coraco-brachialis brevis muscle, but no sharply-marked hollow as in the recent form; moreover the surface is fairly in one plane, and not curved strongly forward as in *O. anatinus*. The distal border of the internal condyle is bordered by well-marked ridges running from the process for the attachment of the pronator teres muscle. The supracondylar foramen is large and well-marked, situated relatively closer to the distal extremity than in the recent species. In *Echidna hystrix* this foramen is relatively much smaller than in *Ornithorhynchus*; and it may be mentioned incidentally that the form of this bone varies very much in these two genera. Speaking generally, the surfaces of the humerus are much smoother in *Echidna* than in *Ornithorhynchus*, and the surface is not so ridged, the supracondylar foramen is much smaller, the external condyle is not so prolonged, there is no well-marked sesamoid bone at the back of the deltoid ridge, while the supinator ridge, that in *Echidna hystrix* runs upwards from the external condyle and separates the posterior and antero-external faces, runs out at about the distal two-thirds, is in *Ornithorhynchus* continued almost up to the head.

Returning now to the fossil form it will be seen that the general form of the trochlea (Pl. XI, Fig. 4) agrees well with that of the recent species. The external condyle is unfortunately slightly damaged so that that is impossible to say with certainty that there was a beak extending out from it to the same marked extent as in *O. anatinus*. The antero-external face is not so deeply

grooved behind the deltoid ridge, which bears a well marked sesamoid, as in the recent species, and the ridge running in the recent species diagonally across the upper portion of this surface, starting from a point just below this sesamoid, and forming one of the boundaries of this groove is not to be clearly seen in *O. maximus*. The area covered in the recent species by the attachment of one of the internal humeral heads of the triceps muscle is represented in our specimen by a fairly well marked attachment scar covering the greater part of this surface. Coming now to the posterior surface we notice first the very well marked supinator ridge running up from the external condyle towards the proximal extremity, this is continued almost to the proximal end in marked contrast to the condition that, as already pointed out, prevails in *Echidna*. This surface is generally flatter than in the recent species. The attachments of the humeral portions of the great triceps muscle are well seen. At the junction of the proximal one-third with the distal two-thirds is a well-marked tuberosity, whose face is convex and smooth, and resembles in position and general character the similar tuberosity in *O. anatinus* which has a well-marked sesamoid bone attached, and which gives attachment to the subscapularis muscle. The structure of this portion is very different from that of *Echidna*.

V.—Conclusion.

The affinities of the Monotreme humerus with that of *Platypodosaurus* and other Anomodont Reptiles from the Trias has already been pointed out by the late Sir Richard Owen in several papers.* He lays especial stress on the great development of the tricipital process in *Platypodosaurus* and remarks on the presence of a similar process in *Echidna*, *Ornithorhynchus*, and in some Marsupials to a less degree. On reference to Pl. XI, Fig. 1, it will be seen that we have a very well marked process before us, though of course not so marked as in the Triassic Reptile figured by Owen. The resemblances between the humeri of Monotremes, Birds and Reptiles, has also been dealt with, among many others, by Dr. Ch. Martins, who in a paper† published in 1874, gives a discussion of the views on this relationship put forward by Home, de Blainville, Meckel, Saint-Hilaire, Cuvier, and Owen, and deals to some length with the degree of twisting of this bone which he considers in Monotremes to amount to 90°.

The discovery of these remains may be summed up as giving the following information:—

1. That they most probably represent the oldest recorded Australian Monotremes, and come from a deposit that is generally admitted to be of Pliocene age.
2. *Echidna robusta* appears to be more nearly related to *Proechidna* than to *Echidna*.

* Quart Journ., Geol. Soc., 1880, XXXVI, pp. 418-420; Phil. Trans., 1884, p. 275. See also Lydekker in Nicholson and Lydekker's Manual of Palæontology, 1889, Vol. II, pp. 1054-1055; Cope, Procs. Am. Assoc. Adv. Sci., 1884 [1885], XXXIII, pp 471-482.

† Ann. Sci. Nat., Zool., & Pal. 1874, XXIX (5), pp. 1-9.

3. That it was much larger and more robust than the living forms and also than *E. Oweni.*

4. Apart from its size and power, it does not appear to be much differentiated from the living forms.

5. In *Ornithorhynchus maximus* we have a gigantic ancestor for our living Platypus, which in the structure of its humerus seems to differ but little except in the point of size.

In conclusion, I have to acknowlege my indebtedness to Dr. W. J. Stewart McKay, M.B., Ch.M., B.Sc., for the great assistance he has rendered me in advice and in putting at my disposal the results of his recent work on *Echidna* and *Ornithorhynchus.**

XXI.—Notes on the Geology of the Auriferous Gravels occurring in the upper portion of the Shoalhaven Valley, N. S. Wales: By J. B. JAQUET, A.R.S.M., F.G.S., Geological Surveyor.

[Plate XIII.]

THE Shoalhaven River has its source in Jinden Mountains fifty miles south of Braidwood, and flows into the Pacific Ocean at Nowra, distant eighty miles in a southerly direction from Sydney.

Throughout the valley, at various altitudes above the present river bed, which seldom, if ever, exceed one hundred and fifty feet, deposits of gravel and other drift material occur; deposits which are composed of the detritus carried down by the stream in past ages when it flowed through channels other than the one it pursues to-day.

All these sediments, which in the aggregate cover many square miles of country and frequently possess a thickness exceeding one hundred feet, contain more or less gold. In a few places the precious metal occurs in sufficient quantity to enable the miner to make a profit by winning the wash-dirt by a system of drifting; in other places mining can only be profitably undertaken when, a convenient supply of water being available, the ground can be sluiced; in yet other places the gravels yield but a trace of gold, and from a miner's point of view are utterly useless. So much of the ground, more particularly where it attains a great depth, is unprospected that one would not, I think, be justified in speaking definitely as to what fraction of the whole drifts each class enumerated above respectively occupies. It is certain, however, that very little gold could be profitably won

* Proc. Linn. Soc. N.S. Wales, 1894, IX (2), Pt. 2 pp. 263-360, pls. 20-23.

except by a system of sluicing, and having regard to the results hitherto obtained, one would expect to find the gravel more often not rich enough for sluicing than contrariwise. On the other hand, there is but little doubt that had not obtaining the requisite water been a difficult and costly operation, placer mining on a very large scale would long ago have been in operation in many places along the valley.

In the past sluicing has been carried on in a more or less desultory manner, and with partial success. Sometimes a few sluice-heads of water have been rendered available by cutting a race and diverting the waters of an affluent stream, or more rarely those of the river itself; again, elsewhere, water at a pressure has been obtained by means of pumps. At "Croaker's Mint," near Oallen, considerable success has attended the introduction of this latter method; for a run of thirty days ninety-one ounces of gold were recently obtained, this result yielding a handsome profit to the shareholders.

I have only had an opportunity of making a detailed examination of the river and its associated formations, in the vicinity of Braidwood—between Jembaicumbene Creek, in the Parish of Boyle, and Reedy Creek, in the Parish of Larbert, and the remarks which follow have more particularly reference to this area; I have, however, made a cursory examination of the geological features both above and below these points, and may in places refer incidentally to them.

The formations represented are as follows:—

Sedimentary
- Silurian—slates and limestones.
- Devonian (Upper)—sandstones, conglomerates, and shales.
- Pleistocene and Recent—auriferous gravels, sands, and clays.

Intrusive and Volcanic
- Acid
  - Hornblende-granite.
  - Quartz-felsite.
- Basic Basalt.

The Silurian rocks are much contorted, and for the most part possess a meridional strike, and dip at a high angle.

The Devonian rocks are either horizontally bedded or but slightly tilted. They occur as outliers, resting unconformably upon the Silurian slates; also are they found in places both upon the quartz-felsite and granite. These beds have yielded, in the neighbourhood of Major's Creek township, specimens of *Lepidodendron australe*, M'Coy, and marine fossils.*

The granite is composed of quartz, triclinic-felspar, dark mica, and hornblende; it is often much impregnated with pyrites. When examined in thin sections under the microscope, the felspar grains are frequently seen to exhibit zonal structure; in one grain examined by the Writer, no less than four periods of growth can be

* Records Geol. Survey N. S. Wales, 1893, III, Pt. 4, p. 199.

distinguished. My late colleague, Mr. W. Anderson, who spent some time examining these rocks, was of opinion that the granite had a later origin than the quartz-felsite.*

The quartz-felsite is composed of much corroded quartz idiomorphs, imbedded in a quartzo-felsitic base, and has either a dark-grey or flesh-pink colour. In places it passes by insensible gradations into a fine-grained felsite. It intrudes the Silurian rocks. I have previously stated that outliers of the Devonian sandstones and conglomerates rest unconformably upon the Silurian slates; and Mr. Anderson has pointed out † that, since in places the basal beds of the Devonian series are in part composed of quartz-felsite pebbles, the sedimentary rocks had a later origin than the intrusive; hence we may be warranted in assuming that the intrusion of the quartz-felsite occurred between the Silurian and Upper-Devonian Epochs.

Dykes of basalt occur at Bell's Creek and elsewhere, while in the Jerrabat Gully, about twelve miles north of Major's Creek township, the older rocks are covered over a small area by a sheet of this rock.

The drifts consist of alternating beds of gravel, sand, and clay. The component pebbles of the gravel, and the grains forming the sand, are for the most part loosely cemented together, though sometimes the latter is of a "running" character. The clay for the most part consists of kaolin, produced probably on the decomposition of the felspars in the granite, it often has a number of angular or subangular quartz grains associated with it. Thin beds of a stiff dark-blue clay occur in those places where the sediments attain a great thickness.

The only organic remains which have hitherto been discovered consist of fragments of silicified wood.

The pebbles which go to form the gravels are for the most part composed of a sandstone which, being lithologically identical with the Devonian sandstone found *in situ*, has evidently been derived therefrom. The fact that boulders of quartz-felsite and granite are, relatively speaking, scarce is probably due to the fact that during the Pleistocene Period, when the greater portion of the drifts were formed, the Devonian outliers covered a much larger area of country; and also to the fact that these rocks more readily underwent disintegration than the sandstone.

The gold occurs as extremely small flaky particles, which are for the most part congregated near the bottom of the beds, though in nearly all cases a little of the metal will be found throughout the gravel. Occasionally it happens that a bed will have gold uniformly distributed through it, and instances are to be found where the upper or central portions of a bed are the richest. Generally speaking, a much larger quantity of gold is contained in the bed of gravel resting immediately on the bedrock than in any other one occurring higher up in the series; yet in a number of instances, a good yield is obtained on a "false-bottom," and

* Ann. Rept. Dept. Mines and Agric. N. S. Wales for 1892 [1893], p. 121.

sometimes an even better one than from the true bottom below. For further information concerning the amount of gold contained in the drifts and the distribution of the same, I may refer the reader to my Reports in connection with the proposed Government Race.*

Accompanying this paper will be found a plan of the drifts (Pl. XIII) occurring upon the Shoalhaven River in the Parishes of Warri and Jinglemoney, together with a section across the same, as proved by shafts put down under the supervision of the Writer.

In the absence of fossils other than silicified wood we are unable to assign any exact age to the sediments; however, they have probably all been formed during Post-Tertiary times, and they are still accumulating at the present day. That a long period of time has elapsed since the oldest drifts were laid down, is evidenced by the height at which they occur above the present river and by their great thickness.

No sharp line of demarcation can in most instances be found between the older and younger deposits; the one more often passes by insensible gradations into the other. Yet, on the other hand, can a variance be observed between drifts of widely different age: *cæteris paribus*, the younger the sediment the richer it is in gold, and the larger the boulders which it includes. The more recent deposits have without doubt been in part formed from the material set free on the disintegration of the older ones; the former in fact bear the same relation to the latter as the concentrates in the sluice-box do to the ground in the face of a claim, and in this manner the larger quantity of precious metal which they contain may be accounted for.

The question will be asked: Where has all this alluvial gold come from? My investigations do not enable me to give any satisfactory answer. It is true that auriferous reefs occur in the granite near Major's Creek and in the quartz-felsite at Jerrabat Gully; but the occurrence of the precious metal *in situ* at these two places would not seem to justify the conclusion that the whole of the gold found in the upper portions of the river had been derived from reefs situated in the intrusives.

Mr. W. Anderson suggested when discussing the probable origin of the gold occurring in the drifts which accompany the Jembaicumbene Creek, a tributary of the Shoalhaven, and other auriferous deposits in the vicinity, that the precious metal had been derived from the denuded portions of the Palæozoic rocks. In connection with this theory, I would point out that in none of the outliers which have escaped denudation have any gold reefs hitherto been found. Reefs in many places occur, and are being worked, in the Silurian slates, but not in the Devonian sandstones and shales of which the outliers are composed.

It is a noticeable fact that coarse gold is only found in the river drifts below the point where Silurian slates become the dominant country rock.

* *Vide* Ann. Rept. Dept. Mines and Agric. N.S. Wales for 1894 (*in litt.*)

XXII.—Mineralogical Notes, No. 3: by GEORGE W. CARD, A.R.S.M., F.G.S., Curator and Mineralogist.

I.—Contents.

1. Andalusite from Tumbarumba.
2. Platinum from Fifield.
3. Gold in Bornite from Woodstock.
4. Gold in Gypsum from West Australia.
6. Iodide of Silver from Broken Hill.
7. [Lavendulan] (?) from Carcoar.
8. Gems from the Oberon District.
9. Pickeringite from Mount Victoria.
10. Magnesia-Zinc-Alum from New England.
11. Oolitic iron ore from Pooncarie.

II.—Mineralogical Notes.

1. *Andalusite from Tumbarumba.*—Rolled pieces from Burra Creek. Specimens have been received from Mr. S. F. Ramsay, of Tumbarumba, and from Mr. J. E. Carne, Geological Surveyor. Masses up to a pound in weight occurred among these The mineral varies from colourless to brown-red and even blue, the different tints sometimes occurring in one and the same specimen. No definite crystalline form is noticeable, the masses having a coarsely radial structure.

A partial analysis, made under the direction of the Assayer and Analyst, Mr. J. C. H. Mingaye, F.C.S., gave the following results*—

Silica ($Si O_2$) about 35 per cent.
Alumina ($Al_2 O_3$) about 60 per cent. with some ferric oxide.
Magnesia (MgO) about 3 per cent.

A very little water and sulphuric anhydride were also present.

The percentage of magnesia present would thus appear to be exceptionally high, andalusite and the allied silicates of alumina not generally containing even one per cent.

Andalusite is said to occur near Bungonia.† Pseudomorphs of a mineral resembling hydro-mica, apparently after andalusite have been found near Cobargo.

2. *Platinum from Fifield.*—Small quantities of platinum have long been known to occur in the auriferous wash of Fifield (Burra Burra, Forbes District). It is now being found in coarse grains, the standard of purity being fairly high.

* 94/539.
† A. Liversidge, Minerals of New South Wales (8vo. London, 1888).

An analysis* by the Analyst and Assayer giving the following results:—

Platinum	75·90
Iridium	1·30
Rhodium	1·30
Palladium	traces.
Osmiridium	9·30
Iron	10·15
Copper	·41
Gold	nil.
Lead	traces.
Insoluble	1·12
	99·48

Three specimens of the drift have been received in which both gold and platinum in a rolled condition are embedded. It is, of course, only by a very loose mode of expression that the metals can be described as "occurring in the matrix," their mode of occurrence being truly alluvial. It is reported that nuggets weighing several grains have been found. Two, very well rounded, are now in the Mining and Geological Museum, weighing 28·7425 grs. and 30·772 grs. respectively.

3. *Gold on Gypsum from West Australia.*—From Lake Austin, Murchison Goldfield. Coarse gold in a small piece of feruginous non-crystalline gypsum. It is said to be associated with pure fibrous gypsum.

4. *Gold on Bornite from Woodstock.*—Free gold on the copper ore of the Burley Jackey Mine. The gold is very pale in colour.

5. *Iodide of Silver from Broken Hill.*—Several fine specimens on kaolin, in the form of plates about one-sixteenth of an inch in thickness. Another specimen shows the iodide in large but indeterminate crystals, on ferruginous oxide of manganese. One or two small crystals of embolite are seated on the iodargyrite. Believed to have come from the Proprietary Mine.

6. *Marshite† from Broken Hill.*—Three very good specimens of this mineral have been recently received. In one of these, sent by Mr. Uhren, of the Proprietary Mine, the marshite occurs in the cavities of a small piece of sooty-black cerussite. One of the edges has a length of three millimetres. Triangular forms—nearly, if not quite equilateral—are very evident. The other two specimens are believed to have come from the same mine. In these cuprite and cerussite, coated with malachite, constitute the main mass, the marshite crystals occupying the cavities. Triangular faces are again very prominent. Many of the faces have a highly-vitreous lustre; others are deeply striated, giving rise occasionally to step-like triangular elevations or depressions.

* 94/506.

† Marshite is an iodide of copper. Its general characters have been described by its discoverer, Mr. C. W. Marsh, in a paper communicated to the Royal Society of New South Wales, by Prof. Liversidge, M.A., F.R.S. (*Journ. R. Soc. N. S. Wales*, 1892). The reactions for copper and iodine can be readily obtained from the smallest fragment. It seems likely that the mineral is not of uncommon occurrence.

In all these specimens the colour of the marshite is a rather light shade of brown, with a more or less pronounced tinge of red.

Some at least of the crystals should lend themselves well to accurate goniometric measurement *in situ*, and it is to be hoped that a detailed crystallographic description of this newly-discovered mineral may soon be forthcoming.

7. *Supposed Lavendulan from Carcoar.*—Some specimens of erythrine from the cobalt mines, brought by Mr. T. W. Atherton in 1893, show a thin encrustation of a lavender-blue substance in part intimately associated with the erythrine. The encrustation is too thin to admit of much being done in the way of testing, but reactions for arsenic and cobalt can be obtained.

8. *Gem-sand from the Oberon District.*—On several occasions recently samples of gem-sand purporting to come from remote gullies to the "west of Mount Victoria" have been submitted for report.

In the first instance, a small *diamond* — a crystal having the form of the hexakis-tetrahedron—was brought in. This specimen is now, I believe, in the possession of a resident of Mount Victoria, who is quite satisfied of its having been found where stated. At subsequent dates four other samples have been received, an examination of which has afforded the following results :—

1. A quantity of blue and green *corundum* (*sapphire*), and of brown and colourless rolled *zircon*.
2. A sample consisting of *quartz*, a very little *topaz*, and red-brown and colourless *zircon*. The coloured zircons occur in beautiful little crystals up to two mm. in length, and of a simple crystallographic form—a prism terminated by a pyramid.
3. Similar to the last, only the zircons were all coloured, and the crystals very perfect.
4. *Quartz* and red-brown *zircon*; the latter in moderately perfect crystals, one with little or no prism. With these stones was submitted a number of pieces of dark-coloured "cement," in one of which could be seen a cavity from which a zircon with pyramidal terminations had been taken. A quantity of the loose stuff was treated with hydrochloric acid, and then washed. It was found to be very ferruginous, and yielded sub-angular *quartz* and some *zircons*, the latter resembling in every respect the stones brought from the district. The "cement" was said to crop out a few feet above the bed of the creek.

Inquiries have shown that the locality where this gem-bearing material occurs is the Duckmaloi Creek, sixteen miles from Hampton, and six from Oberon. It is also stated that a diamond was found there many years ago. The appearance of the zircon cystals is so very characteristic that they can be readily recognised by it as coming from this locality. Their unrolled condition indicates the near proximity of the source from which they have been derived; and there

are, indeed, in the neighbourhood masses of syenitic and other rocks which may well have been their original home. Of course, it by no means follows that the diamonds have been derived from the same source as the zircons.

The zircons are of no value economically, and diamonds have been found at different times in various parts of the Oberon District.

9. *Pickeringite from Mount Victoria.*—Collected by Mr. H. G. Rienits, from crevices in a conglomerate underlying the Coal-measures near the extreme point of the mount. A specimen in the Mining and Geological Museum shows the mineral occupying a crevice about two and a half centimetres wide, which it nearly fills with silky acicular crystals growing transversely in the usual way. A portion of this specimen analysed by the Assayer and Analyst had the following composition:—*

		The soluble portion calculated to one hundred.
Water	37·23	45·08
Alumina (Al_2O_3)	10·65	12·90
Ferric oxide (Fe_2O_3)	1·27	1·53
Ferrous oxide	trace.	.....
Lime (Cao)	nil	.....
Magnesia (MgO)	2·38	2·88
Potash (K_2O)	·74	·89
Soda (Na_2O)	trace.	.....
Sulphuric anhydride (SO_3)	30·28	36·66
Insoluble (sand)	17·89	.....
	100·44	99·94

Neglecting the insoluble material and calculating to one hundred, the percentages in the right-hand column are obtained, and represent the composition of the mineral more exactly. It differs from typical *pickeringite* in the somewhat lower percentage of magnesia—generally given as four—and the higher percentage of ferric oxide—average below one.

10. *Magnesia-Zinc-Alum from New England.*—Said to occur in a vein twenty feet thick. No specimen is available for description.

An analysis in the Departmental Laboratory afforded the following results —*

Moisture (by difference)	43·51
Alumina (Al_2O_3)	9·36
Ferrous oxide (Fe O)	trace.
Zinc oxide (Zn O)	3·34
Cuprous oxide (Cu O)	trace.
Magnesia (Mg O)	5·78
Soda (Na_2O)	·60
Potash (K_2O)	trace.
Sulphuric anhydride (SO_3)	34·62
Phosphoric anhydride (P_2O_5)	·28
Insoluble	2·51
	100·00

* 94-2103.

11. *Oolitic Iron ore from Pooncarie.*—Pooncarie is situated on the Darling River, between sixty and seventy miles north of Wentworth. The ore is a very dark-coloured hydrated oxide of iron weathering red. The oolitic grains have an average diameter of about half a millimetre. They can be well seen in any part of the ore, but are especially conspicuous on the weathered surfaces. It yielded on assay forty-six per cent. of iron and traces of gold and silver.

XXIII.—On the Occurrence of a Stromatoporoid allied to *Labechia* and *Rosenella*, in the Siluro-Devonian rocks of N.S. Wales: by R. ETHERIDGE, Junr., Curator, Australian Museum.

[Plates XIV—XVI.]

I.—Introduction.

THE very interesting fossil now described as *Labechia* (?) (*Cystistroma*†) *Donnellii*, was presented to the Departmental Collection by Mr. D. C. J. Donnelly, M.L.A. for Cowra, who obtained the specimens at the Belubula River, near Cowra, Parish of Malongulli, County Bathurst. Additional examples were subsequently collected by the Government Geologist (Mr. E. F. Pittman) at the same place.

The essential characters of the fossil seem to agree in the main with those of *Labechia*, Edw. and H., at the same time possessing one of the typical features of *Rosenella*, Nicholson.

The anatomical structure of both these genera has recently been worked out in detail, with great success, by Prof. H. A. Nicholson, M.D.‡ and it is owing to his researches that I have been able to arrive at the following conclusions:—

II.—Form of the Cœnosteum.

The form of this organism is that of oval or subreniform expansions of from two to three inches in thickness, arising from a more or less contracted base, that may perhaps represent a point of attachment. The largest specimen is eleven and a half inches across the under surface, by six inches. The second in size is eight inches by six inches.

The largest example (Pl. XIV, Fig. 1) although presenting as a whole an oval outline, still possesses a more or less flabelliform appearance, and is sub-lobate. The latter feature will possibly account for the two weathered prominences one on each side of the second specimen (Pl. XV).

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* 94/30.

† Gen. nov. (ἡ στισκυ, a bladder, and τὸ στρῶμα, anything spread out.

‡ A Monograph of the British Stromatoporoids.—Part 1,—General Introduction (*Pal. Soc.*, 1886).

The appearance of the original of Pl. XIV, Fig. 1, with its nearly central subpeduncular prominence, would lead to the belief, if this be a point of attachment, that the cœnosteum had existed as a tabular or horizontal expansion, for it will be observed that the dark lines, representing the radial pillars, radiate in every direction from this centre.

There is perhaps a tendency to a concave base, as in some of the more massive Stromatoporoids; but there is no evidence to show that the organism grew round or overflowed others, as it were, of any material size; nor is there the slightest trace of any tendency towards a dendroid form of growth.

III.—State of Preservation.

The specimens in their present condition are calcareous, and are preserved in a grey-black, impure, fossiliferous limestone. The skeleton represented by the light-coloured portions on Pl. XVI consists of crystalline calcite, whilst the darker portions represent the dense in-filling of the chambers of the cœnosteum, consisting of an impalpable dark mud. The organisms are so very firmly embedded in the hard tough matrix that it has been found impossible to sufficiently relieve them from the latter to permit a proper macroscopic examination to be made, and all that has been gleaned of their outer characters is from weathered surfaces.

The presence of crystalline calcite would seem to point to a replacement of the original tissues. The preservation of our specimens is analagous to that of *Labechia ohioensis*, described by Nicholson*, viz.: "all the interspaces of the fossil have been filled in with a fine-grained greenish calcareous mud, the skeleton having been subsequently dissolved out and then replaced, more or less completely, with transparent calcite." In the present instance not only are the skeletal tissues replaced, but cavities in the infilling matrix are likewise so occupied. There is, however, as in many other Stromatoporoids, no thin margin of crystals lining these vacuities.

IV.—External appearance.

The general appearance of our largest specimen (Pl. XIV, Fig. 1) is that of an organism composed of successive superimposed concentric layers, or floors, better seen perhaps in the weathered-out portions of the example represented in Pl. XV, rather than on the worn down surface of the subject of Pl. XIV, Fig. 1. These layers, however, are by no means found to be regularly continuous when minutely examined, but thicken and thin out at intervals, and it is only by regarding the entire specimen that the apparently concentric structure becomes apparent. In Pl. XIV, Fig. 1, it is the darker portions that represent the skeleton, and the lighter parts the infilling matrix—just the converse of that seen in Pl. XVI. It is, however, only macroscopically that this appearance exists, for when microscopic sections are examined, precisely the same results were obtained as in Pl. XVI. By following the successive lines of dark floors, a festoon-like appearance is

* *Loc. cit.*, p. 30.

observable that at first sight is very puzzling. The result of microscopic examination has been to convince me that this concentric structure is more apparent than real, and even in the more pronounced specimen (Pl. XV, Fig 1) it is, I believe, simply the result of the exposure of the floors by weathering, and partial excavations of the vesicular tissue. In other words the organism does not split up, or peel off in concentric layers, when broken, like so many other Stromatoporoids. There is also visible a regular series of broken lines radiating outwards from the excentric point of attachment (?), which is itself concavely depressed.

In Pl. XV, the only structure visible is that shown on the two weathered lateral patches, which may have been points of attachment and centres of outgrowth. These are, however, interesting, one in particular, for it exemplifies the stratified appearance in natural section, with the radiating lines of pillars passing from one layer to the other, but, at the same time, without any tendency of the latter to peel off. It is by no means a far-fetched resemblance to compare this with the general structure of one of the cylinders of *Labechia stylophora*, figured by Nicholson*

The upper surface of the cœnosteum has not been observed, and so firmly enveloped are the fossils in the matrix, that it has not been found possible to expose it by mechanical means.

Whether or no an *epitheca* existed is uncertain, but there is no trace of such a covering now. Its absence would not be peculiar among the Stromatoporoidea. That *L.*? (*Cystistroma*) *Donnellii* is not an encrusting organism is I think tolerably certain, but it possibly grew after the manner of *Actinostroma* as described† by Nicholson—"in a succession of superimposed strata, applied first to some foreign body and then to one another."

V.—Internal structure.

The internal structure of *L.*? (*Cystistroma*) *Donnellii* is illustrated in Pls. XIV and XVI. In Pl. XVI, Fig. 1 represents a slice taken at right angles to the plane of growth; Fig. 2 another transverse to the same, or "horizontal"; and Fig. 3 parallel to the plane of growth, or "vertical." In Pl. XIV, Fig. 2 is also given a second and better figure of a transverse or horizontal section. The skeleton of this organism consists of a series of radial pillars (*a*) continuous throughout appreciable distances, and running more or less parallel with one another. These radial pillars are united by transverse, straight, curved, or rolling plates, either as fine delicate lines (*b*), or thickened floors (*c*), irregular in their distance apart, some convex upwards, others concave, and where the pillars are wide apart rendering the interspaces highly vesicular (*e*). The vesicles are lenticular, and in places are filled with clear calcite, at others with the fine mud composing the general infilling medium.

* *Loc. cit.*, 1891, Part 3, t. 20, f. 8.
† *Loc. cit.*, 1886, Part 1, p. 59.

The radial pillars.—The size of these supports is very irregular, both as compared with one another in the same specimen, and those of one individual with those of another. No definite evidence has occurred to show that each radial pillar contained an axial tube, nor am I in a position to state what their condition may have been at the full period of growth. In one pillar, however, there is the semblance of two inner walls (Pl. XIV, Fig. 3), as if a tube had originally existed. The absence of this appearance in the other pillars may be only the result of the high degree of alteration the skeletal tissues appear to have undergone. From the same cause it is impossible to say whether or no dark central spots existed in the centre of the pillars marking the position of canals, with a surrounding concentric laminated ring. Neither am I absolutely certain that the pillars are continuous throughout the cœnosteum; but possibly the variability in the length of the radial pillars arises from "the fact that a section never passes along the plane of any one rod for more than a very limited distance."*

The pillars thicken and thin out irrespective of position in the organism. They certainly lack the regularity seen in some species of *Labechia*, for instance, those of *L. serotina*, Nich.†; but, on the other hand, the interrupted condition is observable in the figures of *L. ohioensis*, Nich.‡, and even to some extent in *L. conferta*, Ed. and H.§, itself. In *Labechia* generally, the radial pillars reach their maximum of development amongst the Stromatoporoidea, being exceedingly stout and generally continuous from the epithecate base to the upper surface.‖ I have observed no trace of either cribriform or porous (vacuolated) structure of the skeletal tissues, nor are tabulæ present in any form.

In a transverse section the appearance of the pillars is very peculiar and quite different to anything seen in *Labechia*. Instead of round, concentrically formed, and tubular pillars, we observe (Pl. XIV, Fig. 2; Pl. XVI, Fig. 3) a series of either irregularly placed, or roughly parallel rods, with one diameter generally very much greater than the other. These pillars are asymmetrically stellate, the outline being broken up into a variable number of radiating denticles or spinelets. The longer ones are usually more or less parallel to one another. Here and there are indistinctly seen the cut edges of the vesicular plates connecting the pillars with one another, or the thickened masses of the flooring already alluded to. These points are even better seen in a second tranverse section (Pl. XIV, Fig. 2). Here the almost lenticular form of the radial pillars is very marked, with their strongly-dentate edges, and general parallel direction. Large and irregular masses of calcareous matter, forming the thickened connecting-plates, are also visible. At one point the section has horizontally cut across immediately above one of the floors, possibly armed with the immature pillars, the latter represented by a series of round dots (Pl. XIV, Fig. 6).

* Nicholson, *loc. cit.*, 1886, Part 1, p. 41.
† Nicholson, *loc. cit.*, 1886, Part 1, p. 46, f. 4B.
‡ Nicholson, *loc. cit.*, 1886, Part 1, t. 2, f. 1.
§ Nicholson, *loc. cit.*, 1891, Part 3, t. 20, f. 1.
‖ Nicholson, *loc. cit.*, 1886, Part 1, p. 44.

Connecting Plates.—The connecting-plates present three different appearances—fine hair-like lines (*b*) visible amongst the dark infilling medium; slightly-thickened lines (*c*) where the original plate has undergone a secondary thickening; and again hair-like lines (*d*) in considerable spaces of the vesicular structure of the organism not mud-filled, but simply impregnated with calcite. The interesting point about all these plates, however, is, that whether in the one or the other condition, there is always visible a series of very minute prickles or denticles rising from the upper side of the plates. These are also traceable in places on the sides of the radial pillars, and in their presence we probably have an explanation of the radiating denticles seen on the pillars in cross section.

It might be advanced that these spinelets, as seen in Plate XIV, Fig. 4, were the starting points of new connecting-plates; but their interrupted and radiating nature (Pl. XIV, Fig. 2; Pl. XVI, Fig. 3), together with the fact that they occur in this condition at the same level, seems to dispel such an idea.

Vesicles.—The vesicular structure is very irregular (Pl. XVI, Fig. 1 & 2), arising from the unstable form of the connecting-plates. In some cases the latter extend completely across the inter-columnar spaces, or are "complete," forming a long narrow vesicle; at other times the plates extend only partially across, when they may be termed "incomplete," thus forming an irregular vesicle; or, again, a subsidiary plate may exist, unconnected with the pillar on either side of it, when the so formed vesicle is more or less central. In some instances the vesicles are filled entirely with fine mud, in others with clear calcite, or small vacuities may occur in the impalpable matrix, themselves filled with calcite, and very much simulating the appearance of the connecting pores of some of the higher groups. The true nature of these spaces is, however, proved by the presence of the much more irregular and larger spaces between some of the floors. It is owing, as in *Labechia*, that "to the entirely irregular development of these vesicles, the cœnosteum shows no tendency to split concentrically, as is observed in the normal Stromatoporoids"*

VI.—*Relations to* LABECHIA.

Like that of *Labechia*, the skeleton of the present fossil consists of pillars, irregularly placed; but unlike those of the former, there is, in the present state of preservation, no definite evidence that the pillars contained axial canals, or were cribriform, or possessed a concentric structure. Again, as in *Labechia*, the pillars were connected by a series of transverse plates, which are either curved or straight, and give rise to the formation of a series of large or small vesicles, but as compared with those of *Labechia*, more irregular in outline. This irregularity of development, however, as in the genus named, prevents the tendency to split or peel off concentrically.

* Nicholson, *loc. cit.*, 1886, Part I, p. 81.

As examples displaying the surface have not been observed, the question of terminal tubercles to the pillars may be left out of the question; nor am I in a position to speak as to the presence of an epitheca, but I suspect that one was present.

To sum up, therefore, *Cystistroma* agrees with *Labechia*, using only those characters definitely ascertained, as follows:—

1. In the presence of radial pillars, and their large size.
2. In the presence of connecting-plates.
3. In the presence of interstitial vesicles.
4. In the absence of any tendency to peel off concentrically.
5. Absence of astrorhizæ.
6. ,, tabulæ.
7. ,, definite zooidal tubes.

On the other hand, *Cystistroma* differs from *Labechia* thus:—

1. Form and more irregular distribution of the radial pillars.
2. Very irregular development of the interstitial vesicles.
3. Presence of short rudimentary growths on the vesicular floors.
4. Presence of similar bodies on the sides of the pillars giving them a more or less dentate appearance in cross-section.

VII.—Relations to Rosenella.

In this genus Prof. Nicholson describes* the cœnosteum as massive or laminar, and the skeleton as consisting entirely of "slightly curved or undulated calcareous plates, which are so combined as to give rise to a series of comparatively large, elongated, lenticular vesicles, upon the convex upper surfaces of which are carried numerous short and rudimentary radial pillars. The radial pillars mostly fall short of the under surface of the lamina next above that from which they spring, and, therefore, appear merely as conical tubercles on the upper surfaces of the vesicular plates."

The passage quoted will at once demonstrate how widely both *Labechia* and *Cystistroma* differ from *Rosenella*, but the remarkable fact still remains that in *Cystistroma* rudimentary projections spring from the vesicular flooring as they do from the laminæ in *Rosenella*. Unlike the rudimentary pillars of the latter, however, they may arise either from a convex or concave vesicle face.

In *Cystistroma* we see well-marked radial pillars that do not occur in *Rosenella*, accompanied by a well-developed vesicular system, apparently more so than in *Labechia*, but less so than in *Rosenella*. In fact, *Cystistroma* appears to be a *Labechia* assuming certain *Rosenella*-like features.

* *Loc. cit.*, 1886, Part. 1, p. 84.

VIII.—Relations to Beatricia.

To this aberrant member of the Labechiidæ, the resemblance of our fossil is comparatively slight, simply in the presence of radial pillars and vesicular tissue. In *Beatricia* the former are much modified and slight. In *Cystistroma* there is not that preponderating influence of the tissue, nor is there any trace of the large axial tube of Billing's genus.

To sum up—Like *Actinostroma*, &c., and contrary to *Stromatopora* proper, *Cystistroma* belongs to the "Hydractinioid" section of the Stromatoporoidea, in which the "radial pillars and concentric laminæ are present as distinct, though closely connected, structures."*

XXIV.—On Blue Dolomite in Lode-quartz: by GEORGE W. CARD, A.R.S.M., F.G.S., Curator and Mineralogist.

A SKY-blue transparent mineral has been several times remarked in the quartz from the Mitchell's Creek Gold-mine, and has been locally regarded as a copper ore. Experiments made upon a fine block of ore presented by the manager, Mr. P. Davies, prove the mineral to be dolomite. This specimen is characteristic of the Mitchell's Creek ore, consisting of white vitreous quartz with patches of iron- and copper-pyrites, the latter sometimes exhibiting the "peacock" tarnish. The quartz is streaked in places by a light-green earthy substance which may perhaps be regarded as chloritic.

The dolomite occupies nests which a very cursory examination shows to be bounded by rhombic outlines, round which the quartz would appear to have moulded itself.

A very small quantity of the mineral was picked out from one of the nests, the comparative lack of hardness and the rhombohedral cleavage being then very apparent. One of the fragments was found to be of a hardness between 3 and 4 of Moh's scale. The small pieces were transparent, and colourless except for a sky-blue (sometimes greenish-blue) band traversing them parallel to one of the cleavage faces at a little distance from the surface. It is this colouration-band which gives the prevailing blue tint to the mineral as seen in mass.

On heating gently the blue colouration disappears and the mineral becomes more or less opaque, assuming a brownish tint. The decrepitation consequent on heating gives rise to very perfect cleavage-rhombohedra. It has been suggested

* Nicholson, *loc. cit.* 1886, Part I, p. 41.

that the blue and greenish tints may be due to *vivianite*, and it may be that the change of colour and loss of transparency on heating are due to per-oxidation of iron. The presence of lime is readily detected by flame tests.

Unattacked by cold dilute hydrochloric acid the mineral is completely soluble with effervescence on warming. By an examination of a very small quantity of the powder, Mr. F. B. Guthrie, F.C.S., has chemically established beyond all doubt the presence of a considerable quantity of magnesia.

It is evident from the above reactions that the mineral is a carbonate of lime and magnesia possessing all the physical properties of dolomite.

In the 1892 edition of Dana's 'Mineralogy' mention is made of a green variety, but there seems to be no record of a blue one.

Mr. F. D. Power, A.R.S.M., F.G.S., informs me that a similar variety occurs at Maldon, County Talbot, Victoria, but that the supply must be nearly exhausted.

In the Mining and Geological Museum there is a small specimen of white vitreous quartz, containing blue dolomite described as coming from Woodford, Victoria, which only differs from the Mitchell's Creek stone in not being mineralised.

PLATE X.

A portion of Slide No. 444 in the Collection of the Geological Survey of N. S. Wales—x 62. A corner of one of the porphyritic idiomorphic crystals of felspar is shown. The margin is corroded, and there is a band of inclusions. This crystal is untwinned and quite unaltered, but the polarization effects are irregular.

A number of lath-shaped felspars are embedded in the glass, a few of them exhibiting square sections. The tendency to flow round the porphyritic individual will be noted, as well as the bending and breaking of some of them.

Drawn from nature by Mr. P. T. Hammond.

P. T. Hammond, del.

Heliotyp

PLATE XI.

Ornithorhynchus maximus, *Dun.*

Fig. 1. Right humerus, posterior view.
Fig. 2. Do do anterior view.
Fig. 3. Do do articular head.
Fig. 4. Do do articular tuberosity for the head of the radius.

Echidna (Proechidna) robusta, *Dun.*

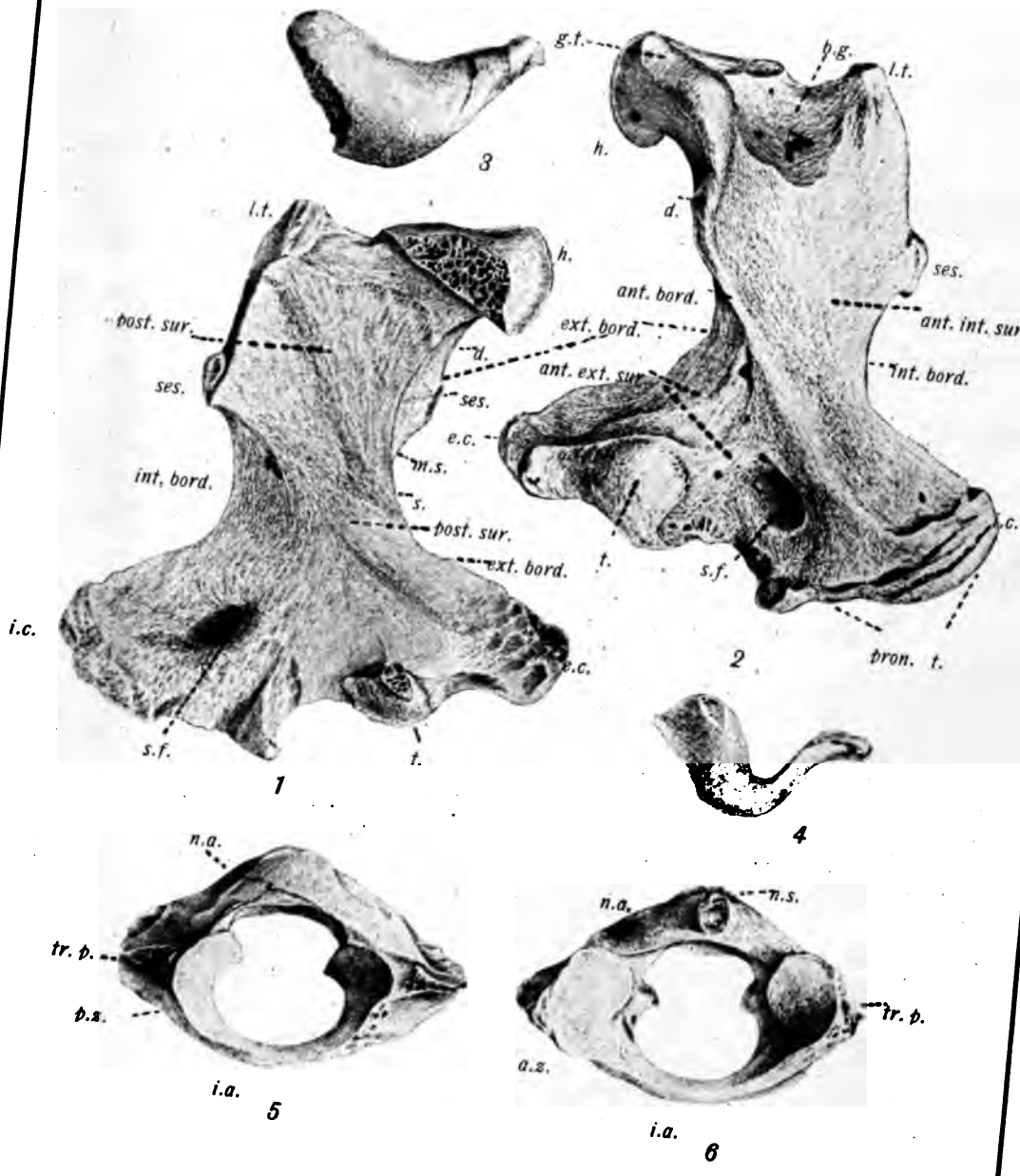
Fig. 5. Atlas vertebra, posterior aspect.
Fig. 6. Do do anterior aspect.

Reference Letters.

Humerus :—*g.t.*, greater tuberosity; *l.t.*, lesser tuberosity; *b.g.*, bicipital groove; *h.*, head; *ses.*, sesamoid; *ant. int. sur.*, antero-internal surface; *int. bord.*, internal border; *ext. bord.*, external border; *pron. t.*, attachment surface of pronator teres muscle; *s.f.*, supracondylar foramen; *e.c.*, external condyle (ectepicondyle); *i.c.*, internal condyle (entepicondyle); *ant. ext. sur.*, antero-external surface; *ant. bord.*, anterior border; *d.*, deltoid ridge; *s.*, supinator ridge; *t.*, trochlea; *m.s.*, musculo-spiral groove.

Vertebra :—*i.a.*, inferior arch; *n.a.*, neural arch; *a.z.*, anterior zygapophysis; *p.z.*, posterior zygapophysis; *n s.*, neural spine; *tr. p.*, transverse process.

Drawn from nature by Mr. P. T. Hammond.



P. T. Hammond, del.

Heliotype

PLATE XII.

Echidna (Proechidna) robusta, *Dun.*

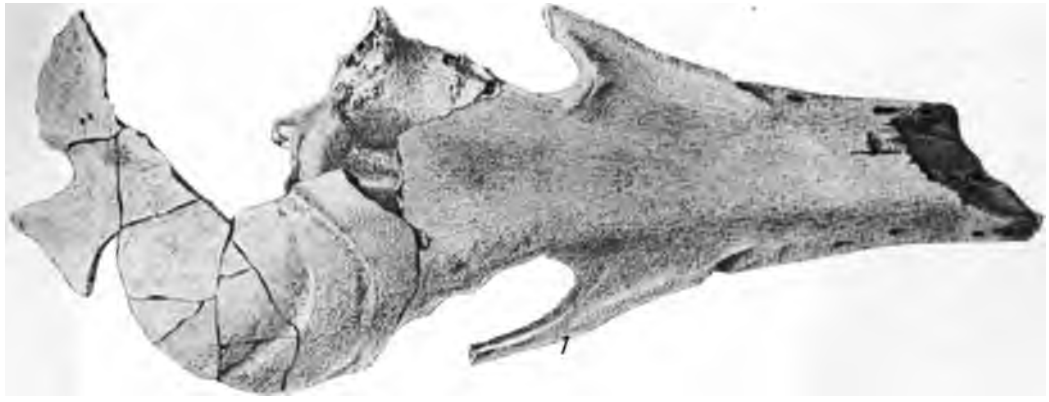
Fig. 1. Portion of cranium and rostrum, upper view.

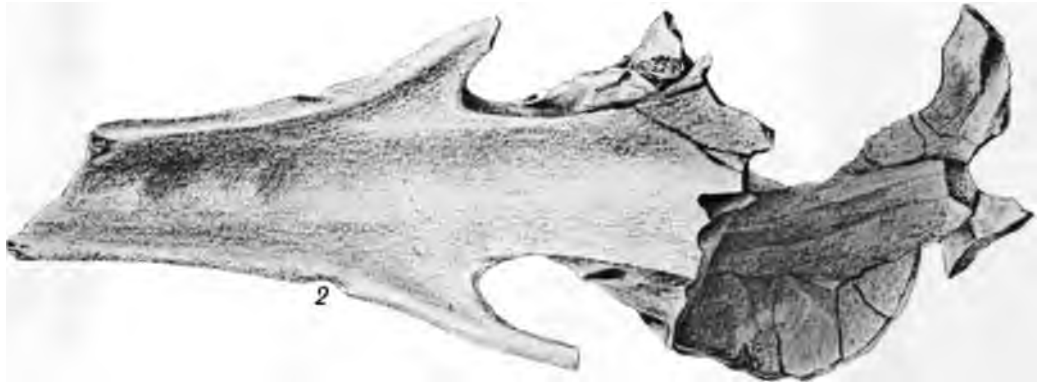
Fig. 2. Do do lower view.

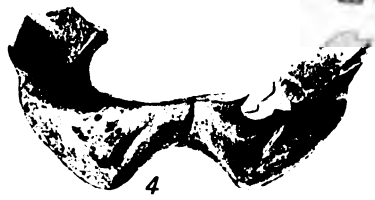
Fig. 3. View of occipital region of skull, viewed from within.

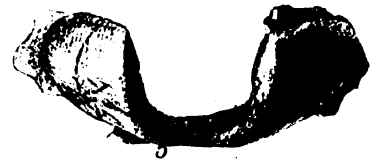
Fig. 4 and 5. Do do viewed posteriorly.

Drawn from nature by Mr. P. T. Hammond.









P. T. Hammond, del.

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PLATE XIII.

Map of a portion of the Shoalhaven River, Parishes Warri and Jinglemoney, County Murray, showing auriferous gravels, sands, and clays. The bed rock is shown by star-hatching.

Horizontal section on line x y, showing the position of the auriferous gravels, &c.

Four vertical sections, positions shown on the Map by the letters C, D, E, and F.

The scales are shown on the face of the Plate.

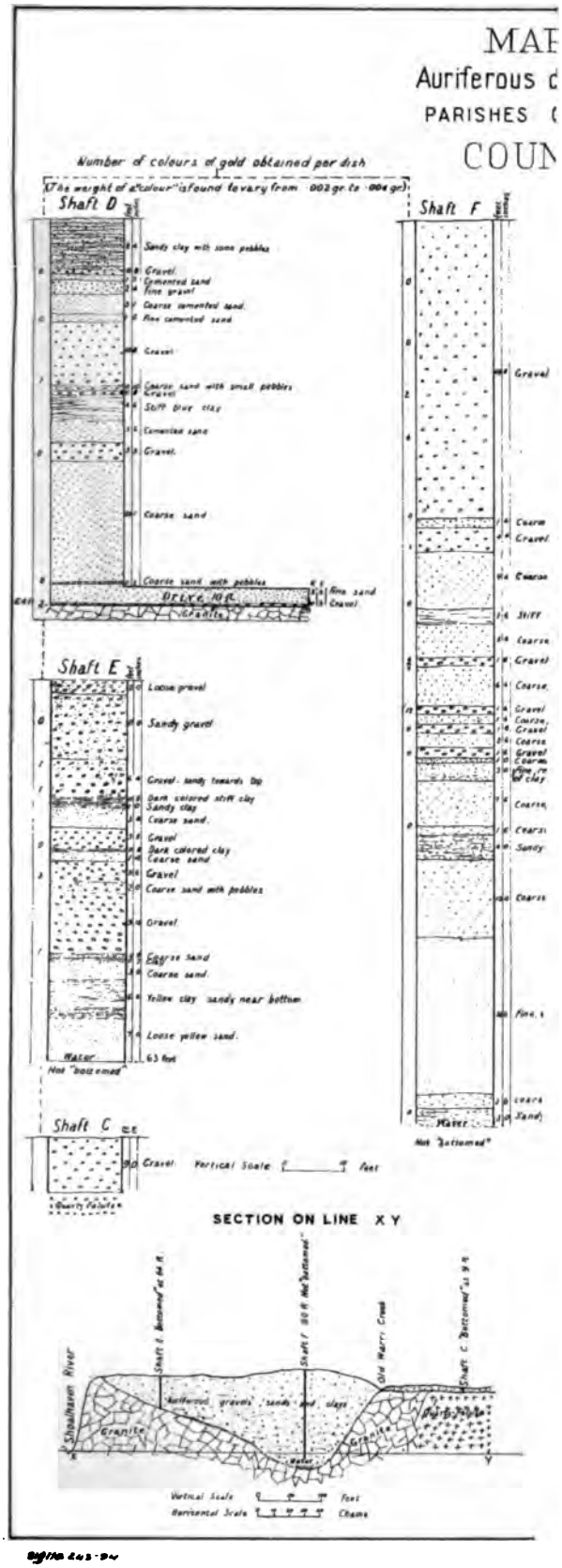

MAP
Auriferous d
PARISHES (
COUN
Number of colours of gold obtained per dish
(The weight of a "colour" is found to vary from .002 gr. to .004 gr.)
Shaft D
Sandy clay with some pebbles
Gravel
Cemented sand
Fine gravel
Coarse cemented sand
Fine cemented sand
Gravel
Coarse sand with small pebbles
Gravel
Stiff blue clay
Cemented sand
Gravel
Coarse sand
Coarse sand with pebbles
Drive 10 ft.
Granite
Fine sand
Gravel
Shaft E
Loose gravel
Sandy gravel
Gravel - sandy towards top
Dark colored stiff clay
Sandy clay
Coarse sand.
Gravel
Dark colored clay
Coarse sand
Gravel
Coarse sand with pebbles
Gravel
Coarse sand
Coarse sand.
Yellow clay sandy near bottom
Loose yellow sand.
Water
63 feet
Not "bottomed"
Shaft C
Gravel
Quartz Pebbles
Vertical Scale
feet
Shaft F
Gravel
Water
Not "bottomed"
SECTION ON LINE X Y
Shaft E "Bottomed" at 64 ft.
Shaft F 80 ft. Not "bottomed"
Old Warri Creek
Shaft C "Bottomed" at 9 ft.
Shoalhaven River
Auriferous gravels, sands and clays
Granite
Granite
Water
Vertical Scale
feet
Horizontal Scale
Chains

PLATE XIV.

Labechia? (Cystistroma) Donnellii, *Eth. fil.*

Fig. 1. The largest specimen known, showing weathered surface, with radial pillars, connecting plates, and vesicular structure—$\frac{1}{2}$ nat.

Fig. 2. Section at right angles to plane of growth, or "horizontal," showing radial pillars of an elongated form with marginal serrations—nat.

Fig. 3. A radial pillar, seen in vertical section, showing what appears to be an axial tube—nat. This figure is somewhat exaggerated for purposes of delineation.

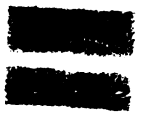
Fig. 4. A radial pillar, in vertical section, showing marginal denticles—nat.

Fig. 5. Two connecting plates, in vertical section, showing denticles, possibly immature radial pillars—nat.

Fig. 6. Portion of a thickened connecting plate in horizontal section, showing the bases of denticles, possibly immature radial pillars—x 4.

Drawn from nature by Mr. P. T. Hammond.

3



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P. T. Hammond, del.

PLATE XV.

Labechia? (Cystistroma) Donnellii, *Eth. fil.*

Fig. 1. The second largest specimen, with two weathered prominences, perhaps representing points of attachment—½ nat.

Fig. 2. The upper portion of Fig. 1, approximately enlarged three-quarters.

Drawn from nature by Mr. P. T. Hammond.

2

1

P. T. Hammond, del.

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PLATE XVI.

Labechia? (Cystistroma) Donnellii, *Eth. fil.*

Fig. 1. Section at right angles to plane of growth—x 2.

Fig. 2. Section parallel to the plane of growth, or "vertical"—x 2.

Fig. 3. Section transverse to plane of growth, or "horizontal"—x 2.

a. Radial pillars.

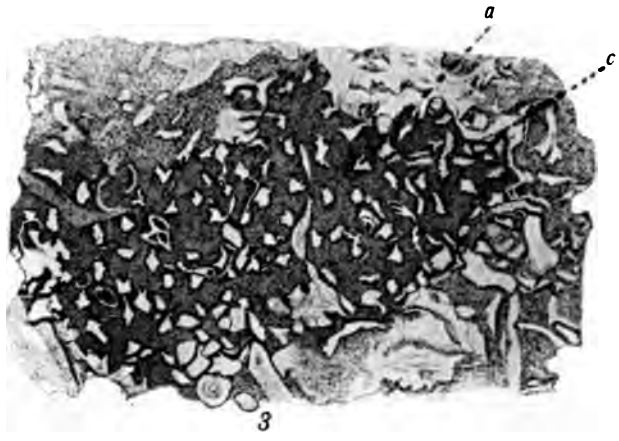
b. Connecting plates as delicate lines.

c. Do do as thickened floors.

d. Do do as hair-like lines forming vesicular tissue in portions of the organism filled with clear calcite.

e. Highly vesicular structure.

Drawn from nature by Mr. P. T. Hammond.



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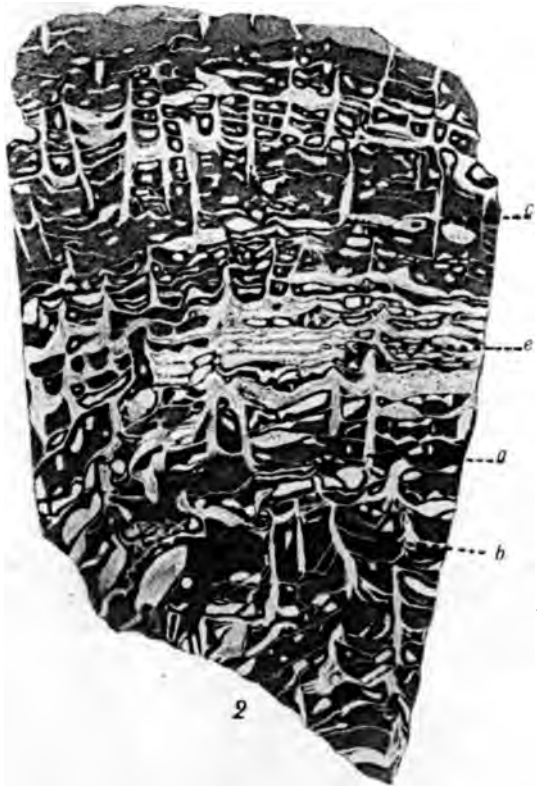

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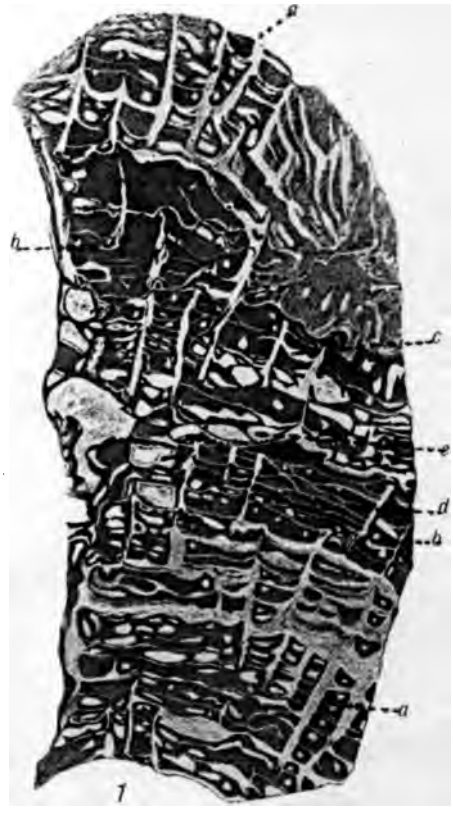

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P. T. Hammond, del. Heliotype.

DEPARTMENT OF MINES AND AGRICULTURE, SYDNEY.

RECORDS

OF THE

GEOLOGICAL SURVEY OF NEW SOUTH WALES.

Vol. IV.] 1895. [Part 4.

XXV.—On the Cretaceous Formation in the North-western portion of New South Wales: by E. F. PITTMAN, A.R.S.M., Government Geologist.

PREVIOUS examinations of portions of this country have been made by Mr. Geological-Surveyor Brown* (now Government Geologist of South Australia) in 1881; by Mr. C. S. Wilkinson,† late Government Geologist of New South Wales, in 1884 and 1887; by Mr. Geological-Surveyor Wm. Anderson,‡ now of the Geological Survey of India, in 1891; and by Mr. Geological-Surveyor J. B. Jaquet,§ in 1892.

Briefly summarised their reports are to the effect that this territory consists of several areas of Palæozoic rocks (intruded by dykes of granite, diorite, &c.), which contain deposits of such metals as gold, silver, copper, and tin, and which are flanked or surrounded by Cretaceous or water-bearing sediments, covered in places by drifts and sands of Pleistocene and recent origin.

The examination of this district recently made by me convinces me that the Palæozoic areas shown on our geological map must be considerably reduced, and, that on the other hand the area occupied by the Cretaceous or water-bearing rocks is much larger than was previously supposed.

* Report upon the Albert Gold-fields, &c., especially with reference to the existence of Artesian Water, &c. Leg. Assembly Paper. (Fscap. Sydney, 1881, by Authority.)

† Ann. Rept. Dept. Mines N.S. Wales for 1884 [1885], pp. 146, 147; *ibid* for 1887, pp. 137-9; Report on Silver-bearing Lodes of Barrier Ranges. Leg. Assembly Paper. (Fscap. Sydney, 1884, by Authority.)

‡ Ann. Rept. Dept. Mines. N.S. Wales for 1891 [1892], p. 254.

§ Ann. Rept. Dept. Mines. N.S. Wales for 1892 [1893], pp. 137-145.

Perhaps the most important conclusion at which I have arrived is that the artesian basin has probably a much further extension *southwards* than had been previously assigned to it. It has hitherto been considered that the southern boundary of the Cretaceous basin was formed by a bar, or buried range of Palæozoic rocks stretching westward from Cobar through Wilcannia to Scrope's Range. At Wilcannia the rocks forming this supposed bar were regarded as *Devonian*, and this opinion appears to have been formed on lithological evidence only, as there is no record of any Devonian fossils having been found in situ, nor of any geological section in which the relation of these Wilcannia sandstones is described with regard to older sediments. But in my opinion the lithological character of these sandstones points to their being of Mesozoic rather than of Palæozoic age, and the small amount of geological evidence that can be obtained from a surface examination seems to strengthen that view. Deposits of hard sediments which I observed at certain localities such as at the west of the Koko Range, at Kooningberry, at the western end of Mount Murchison, at the western side of Woychugga Lake, at the Springs, and at the northern end of Scope's Range, may be and probably are of Devonian age. They consist of hard, dense, thick-bedded quartzites, similar in character to those of Mount Lambie, near Bathurst, showing slickensided joints, and as a rule, lying at a high angle with the horizon. But the rocks at Wilcannia are of a different character. They consist of soft, yellowish, greyish, and whitish grits and sandstones, frequently containing bands and pockets of kaolin, and lying, as a rule, at a very low angle of inclination. In fact while one set of rocks shows abundant evidence of both metamorphism and disturbance, the other is remarkably free from signs of either.

My conclusion in regard to these rocks is, that they are probably of Upper Cretaceous age, and if this be correct it means that, instead of the Cretaceous basin being cut off on the south by an east and west boundary through Wilcannia, there may be a deep channel somewhere between Woychugga Lake and Mount Manara by which the artesian basin may have extended far to the soutwards, possibly even under the Eocene beds of the lower Darling of the north-western portion of Victoria, and part of South Australia to the neighbourhood of Mount Gambier, where fresh water has long been known to escape as springs on the sea-coast, as was first pointed out by the Rev. Tenison Woods.* It is quite possible, however, that this water may be derived from the Eocene beds themselves, and not from underlying Cretaceous beds.

In any case the probabilities of the artesian water-bearing beds, extending southwards from Wilcannia, appear to be strengthened by the occurrence of Upper Cretaceous rocks (Desert Sandstone) at Bidura, near Balranald, as reported by me in June last, and also by the fact that a deep channel has been proved to extend from Urisino (where two fine supplies of water have already been obtained)

* Geological Observations in South Australia. 8vo. London, 1862.

southwards along the west of the Paroo, in the direction of Wilcannia, for I understand that several deep private bores were put down on Momba Station. The deepest of these was 2,000 feet, but I believe that boring operations were discontinued before bedrock was reached.

I propose, during the coming year, to make a geological inspection of the country along the southern course of the Darling, with the object of supplementing the information already obtained; but the only satisfactory way of settling this question is by boring, and I am of opinion that there is sufficient geological evidence to warrant the expense of a series of bores to the south of Wilcannia.

In my journey northwards from Broken Hill, the Upper Cretaceous rocks were first met with at Fowler's Gap, to the north-east of Corona Station. A good section of these beds is seen four miles west of Sandy Creek bore, and also twelve to fifteen miles west of Bancanya bore, where they form the eastern escarpment of the Koko Ranges. They consist of soft, yellowish-grey, sandstone and grits, often showing false bedding, and often stained by peroxide of iron. They are in fact in no respect distinguishable (lithologically) from the sandstones subsequently examined at Wilcannia. On the western flanks of the Koko Range these sandstone beds are seen to lie unconformably on the upturned edges of slate rocks of probably Upper Silurian age. The sandstones here dip to the east at a low angle (about ten degrees), but as they are followed eastwards the dip is seen to increase, until at the eastern side of the range it attains an angle of forty-five degrees. It is unusual to find the Upper Cretaceous rocks as highly inclined as this, but at least one instance of as high a dip as the above has been observed in Queensland, for Mr. W. H. Rands (Assistant Geologist) has measured a dip of forty-five degrees in Desert Sandstone rocks on the Isis River.*

In many other localities as at Milparinka, Mount Poole, Mount Stuart, and in the Grey Ranges, similar soft sandstones—but dipping as a rule at a very slight angle—are met with, and these frequently alternate with, or are sometimes overlaid (conformably) by hard rocks, which, though somewhat of the nature of quartzites, are perfectly distinct from the Devonian rocks previously alluded to. The latter are highly metamorphosed *homogeneous* quartzites, while the Upper Cretaceous rocks appear to be grits which have been altered by thermal springs—they have in fact become opalised or porcelainised by having all the interstices between the sand-grains or pebbles completely filled by silica deposited from solution. One of the characteristics of this porcelainised rock is the manner in which it breaks up on the hill-tops. It is extremely hard but also extremely brittle. It " rings" like porcelain when struck, and breaks with a conchoidal fracture. The prolonged heat of the sun followed by rapid cooling of the surface, owing to thunderstorms and the frosts of winter, causes the larger pieces of stone

* Jack and Etheridge. Geology and Palæontology of Queensland and New Guinea. (8vo, Brisbane, 1892, by Authority.) P. 543.

to exfoliate and break up rapidly, and consequently it is rare to see an outcrop of solid beds—the hill-tops being covered with a more or less rounded shingle like that so characteristic of Sturt's Stony Desert.

Evidences of the agency of thermal springs are frequent in the Upper Cretaceous rocks. At the Peak (Mount Stuart Range) ancient thermal springs have left mounds of curiously-banded limonite, showing that many of them contained ferruginous as well as silicious solutions, indeed the Upper Cretaceous rocks are characterised by the occurrence of considerable quantities of iron oxide.

Near the top of the Upper Cretaceous rocks, in the elevated lands, there is a bed of conglomerate a few inches thick, consisting of pebbles of an infinite variety of colour, and owing to the breaking up of this conglomerate by weathering the lower ground is in many places strewn with highly-polished pebbles of banded agates, chalcedony, jasper, carnelian, pink and white quartz, &c. The extremely high polish which these stones exhibit is probably due to the action of the wind and sand.

The whole of the country between the Waratta Ranges and the Queensland Border is more or less overlaid by these Upper Cretaceous rocks, and they appear to extend for a good many miles to the east and west. In none of the country traversed by me were the Lower Cretaceous rocks (Rolling Downs Formation of Queensland) to be seen outcropping at the surface, there being always a capping of either Desert Sandstone or of Pleistocene sands to hide them from view. But in the spoil-heaps of many of the wells which have been put down by the pastoral lessees are to be seen the characteristic blue clays and sandy shales of the Lower Cretaceous Formation containing *Belemnites*, *Maccoyella reflecta*, *Maccoyella corbicnsis*, &c. I also obtained a specimen (presented by Mr. A. Lang) of a very large bivalve, which Mr. Etheridge believes to be new, and Mr. Warden Maitland presented me with a specimen (from the Upper Cretaceous rocks of Mount Stuart) of a fossil tree-fern which is also new to Australia.

Very large tracts of this North-Western District are covered by recent deposits in the shape of "sandhills" and "claypans," and, as these form quite a notable feature in the character of the country, they are worthy of a brief description. They are very extensively developed along the Wanaaring to Milparinka Road, particularly between the Clifton Bore and Milparinka; but patches of them are met with in various parts of the North-Western District. The sandhills, which vary from small mounds to hills of fifty feet in height, are formed of blown sand. In many cases their surfaces are being continually modified by the action of the wind, and as can be easily imagined they make the roads exceedingly heavy for travellers. The sand of which these hills are formed evidently owes its origin to the disintegration of the Upper Cretaceous sandstones. The claypans are flat-bottomed shallow depressions which occur in the neighbourhood of the sandhills.

They vary in depth from a few inches to about three feet, and the floor consists of fine clay upon which the water lies for a considerable time after rain. They are often quite circular in form, while at other times they are seen to form long channels of regular width. It seems probable that they may have been formed by the whirlwinds (the "Burramugga" of the blackfellows) which are of very common occurrence in this country. Some of these whirlwinds remain stationary for a considerable time—which suggests the formation of the circular depressions—while a travelling whirlwind of unusual severity might be expected to sweep up the sand in such a way as to form the long narrow channels. The depressions having been thus formed subsequent rains have carried into them in suspension fine clay washed out of the surrounding sandy soil. When the water has afterwards evaporated by the heat of the sun, or sunk into the floor of the depression, a coating of clay has been left, and frequent repetitions of this process have left a thick floor of clay forming a hard and impervious bed for the water.

One of the most interesting geological features of this district is the occurrence at Mount Browne and Tibooburra of auriferous drifts of Cretaceous age. This was, I believe, first noticed by the late Mr. C. S. Wilkinson, Government Geologist.*

At the Western end of Mount Browne a rounded quartz pebble drift, which has proved to be highly auriferous, and has been extensively worked on a small rise known as Billygoat Hill, dips suddenly beneath the level of the Upper Cretaceous sandstones which surround the Mount Browne Range. This quartz pebble drift takes its rise in the Mount Browne Range (which is composed of Upper Silurian slates with numerous quartz reefs) somewhere near the Four-mile diggings, and it trends, with a gradual fall, in a more or less South-westerly direction for about four miles to Billygoat Hill—on the top of which the drift is seen to be about three to four feet in thickness, lying on rather decomposed slate rocks. From here it is evident that the old Cretaceous creek or river fell over a slate cliff, for in a distance of little more than one hundred yards west the drift has been followed to a depth of two hundred and forty feet in the Mount Browne Gold-mining Company's shaft—operations in which were discontinued owing chiefly to the strong body of water met with.

The gold from the higher portions of this old drift has been re-distributed during later times, and has been worked in shallow deposits in numbers of the small gullies heading from the Mount Browne Range.

At Tibooburra the auriferous Cretaceous drifts dip off an area of granite rocks.

Another instance of gold being found in Cretaceous rocks was observed at a place called the Peak, between Kayunnera and Tarella, on the Milparinka-Wilcannia road. The Peak itself is an isolated conical hill of Upper Silurian slates,

* Ann. Rept. Dept. Mines N. S. Wales for 1884 [1885], p. 137; Records Geol. Survey N. S. Wales, 1889, I, pt. 1, pp. 1-9.

capped (unconformably) by Upper Cretaceous quartz and ironstone conglomerate. In the adjoining hills to the north of the Peak, the conglomerate dips to the north-east under a considerable thickness of Upper Cretaceous sandstone. The tenant of the Peak Government Tank (Peter Riley) has obtained a fair amount of alluvial gold by following the ironstone conglomerate to the dip, and also by working the recent gullies which intersect it, and in which the gold has been reconcentrated.

Opal-mining in Upper Cretaceous rocks at the White Cliffs is still being carried on by about one hundred miners, and there is every reason to suppose that the industry will be a permanent one. The opal is being found in small horizontal and vertical pipes in a soft white rock, which is locally termed kaolin, but which appears to consist mainly of fine silica. A considerable area of ground has been broken in prospecting for opal, but very large areas still remain untouched; and I can see no reason why they should not yield good opal for many years to come. There is no surface indication of the occurrence of the gem, and consequently there is a great deal of the element of chance connected with prospecting operations. Hitherto the bulk of the opal has been obtained at a depth of about twelve feet from the surface, and the workings have mostly been confined to this level, apparently under the impression that it would be useless to look deeper for the stone. I am of opinion, however, that this is a mistake, and that opal may be expected to occur at much greater depths than it has hitherto been found.

XXVI.—On the Occurrence of a Plant in the Newcastle or Upper Coal-measures possessing characters both of the Genera *Phyllotheca*, Brong., and *Cingularia*, Weiss: by R. ETHERIDGE, Junr., Curator of the Australian Museum.

[Plates XVII—XIX.]

I.—Introduction.

MR. J. B. HENSON, C.E., Engineer to the Water and Sewerage Board, Newcastle, has lately been successful in obtaining a number of disjointed plant-remains from the Newcastle or Upper Coal-measures, from the cliff face at Shepherd's Hill, Newcastle, displaying features on the one hand resembling those of *Phyllotheca* Brong., and on the other to some extent those of the genus *Cingularia*, Weiss. The latter is a plant of doubtful systematic position found in the Saarbrück Coal-field, but believed to be allied to the Calamitidæ.

In addition to Mr. Henson's plants, a single peltate infundibuliform leaf (?) was obtained in the Cremorne Bore No. 1, Robertson's Point, Port Jackson, at a depth of 2,900 feet, also an horizon in the Upper Coal-measures.

The specimens collected by Mr. Henson consist of compressed stems, branches, whorls of leaves, and verticillate bracts (?) *in situ*. These have been generously presented to the Departmental Collection by the discoverer.

II.—Geological Position.

The plant-bed at Shepherd's Hill consists of a grey to cream-coloured shale immediately underlying the cap of the cliff, a thick conglomerate, and about two hundred and forty feet above sea level. Between the latter and the shale in question are four coal seams (Pl. XIX).

Sir F. McCoy speaks* of the "whitish clay beds of Mulubimbah," as furnishing his specimens of *Phyllotheca*. Mulubimbah is the native name for the Newcastle District, and I am led to believe that his *Phyllothecæ* were derived either from the same bed as Mr. Henson's, or from an extension of it.

III.—Description of the Plant-remains.

Stems.—The longest stem preserved is six inches, and like all the other fragments is divided into nodes and internodes. The nodes are generally speaking from half to one inch apart, and but little enlarged above the diameter of the internodes. In their present compressed state the stems vary in width, but the broadest observed is three-quarters of an inch (Pl. XVIII, Fig. 2). There are six internodes distinctly visible within the measurement above given. The surface of the stems is longitudinally costate, the costæ now being flat, but in their perfect state were probably slightly convex. They are opposite to one another in contiguous internodes, each costa, therefore, being continuous throughout a stem. No absolute connection has been seen between the stems and branches, but they occur together to the exclusion of other plants. In two instances the peculiar tubercles or discs seen on *Equisetum* stems occur, and which Schimper speaks† of as liberated diaphragms consequent on maceration. They have also frequently been figured on the stems of *Phyllotheca*, although these discs were not preserved on the original specimens of this genus so ably described‡ by Sir F. McCoy, who also noticed the continuity of the costæ in *Phyllotheca*. No better illustration of these in *Phyllotheca* can be given, than certain figures of Heer's *P. sibirica*.§

Leaves.—The leaves are chiefly scattered over the surface of the shale hand-specimens, but in a few instances are attached to the leaf sheaths (Pl. XVIII, Figs. 4 and 5). The latter are short, and in a few instances are attached to the stems,

* Ann. Mag. Nat. Hist., 1847, XX, p. 153.
† Zittel's Paléontologie. Pt. II Paléophytologie (French Edit.), p. 153.
‡ Ann. Mag. Nat. Hist., 1847, XX, p. 156.
§ Flora Foss. Arctica, IV, Pt. 2, t. 4, f. 1—5.

which they completely encircle in a subinfundibuliform manner. They are long-linear, completely separated to the sheath edges, uninervate, curve obliquely outwards, and are sharp pointed distally. There are at least twenty in every verticil, and possibly more. Each verticil appears to reach from node to node, and even beyond, so that the stems are wholly clothed, or enveloped in leaves.

So far, this is precisely the structure seen in *Phyllotheca*. A reference to McCoy and Dana's figures, by far the best yet published of the Australian *Phyllothecæ*, will demonstrate this. McCoy says *—"the joints surrounded by sheaths, and the free edge of each sheath terminating in a whorl of long, linear leaves." By Brongniart, the stems of aged individuals of the generic type, *P. australis*,—were described† as smooth between the sheaths, but McCoy has shown ‡ that one of his species (*P. ramosa*) resembles this type, the other having coarsely sulcated, and longitudinally ridged stems (*P. Hookeri*). He further describes the leaves as long and narrow, with a more or less distinct mid-rib. The naked stems amongst our specimens, I cannot do better than compare with the similar examples figured § by Dana, as *Phyllotheca*, sp., and those fragments with leaves attached, referred by him to *P. australis*, Brong., both of which it seems to me are referable to *P. Hookeri*, McCoy. Dana's measurements also agree excellently with those of our examples, one of his being six and a half inches long, and half an inch broad ‖.

Peltate Leaves (*or* "*Bracts*"?)—The largest proportion of the Newcastle specimens consist of peltate infundibuliform leaves (?) lying about on the shale surfaces in all conditions and positions (Pl. XVII, Figs. 1–5, 7–9; Pl. XVIII, Fig. 3), many of them very perfect, and attached to branches having the same general characters as the stems. These leaves, if that be their nature, spring from a sheath enclosing the branch, like the linear leaves. This encircling sheath, before the expansion of the peltate leaf commences, is about two-eighths of an inch long. The organs themselves form an inverted umbrella-like expansion, circular at the periphery, and there extended into a series of tooth-like projections or spikes, the re-entering spaces between being concave. It is difficult to give the exact number of these projecting points in each leaf, but probably more than thirty exist in fully-matured examples, as twenty-three have certainly been counted. The surface is slightly, but very regularly crumpled transversely, after the manner of a fan. Many specimens spread open during fossilisation enable the size of these interesting organs to be determined, the largest measured having a diameter of one and a quarter inches. In some few instances the encircling

* Ann. Mag Nat. Hist., 1847, XX, p. 153.
† Prodrome Hist. Vég. Foss., 1828, p. 152.
‡ Ann. Mag. Nat. His., 1847, XX, p. 157.
§ Wilkes U.S. Expl. Exped. Vol. X, Geology, 1849, Atlas, t. 14, f. 2.
‖ Wilkes U.S. Expl. Exped. Vol. X, Geology, 1849, p. 719.

depression of attachment is shown (Pl. XVIII, Fig. 3). Each expansion is traversed by radiating costæ (or nerves?), one to each denticle, whilst each intercostal space bears a faint groove or depression, corresponding to each re-entering angle between the costæ. The intercostal spaces are also crossed by the finest possible transvere striæ, arranged in a festoon-like manner.

For a *possible* elucidation of these peltate organs we may profitably study the structure of the genus *Cingularia*, Weiss. In *Cingularia* the stem is jointed or articulated like those of *Calamites* or *Equisetum*, divided into nodes and internodes, and longitudinally sulcate. The branches are opposite, or arranged in a verticil around the nodes, longitudinally striate like the stems, and bear the leaves and spike-like fructification. The foliage is also arranged in a verticillate manner the leaves being free to their bases. Each leaf is long, linear-subulate, and is traversed by a median nerve. The fructification of this plant is very remarkable. It is pediculate and spike-like, terminating the lateral branches above the foliage-bearing portion, but its component parts have been differently interpreted by writers.

According to Schimper*, the fructification is verticillate, consisting of from fourteen to twenty horizontal, longitudinally striate, unilamellar, linear, cuneate bracts, each segment in the young state ending in a point, and then at maturity becoming truncate and inbent. There is also a transverse sulcus toward the distal end, before and behind which is a scar representing the attachment of a sporangiophore.

On the other hand, Weiss,† who appears to have studied *Cingularia* more than any other writer, believes that the verticillate bracts, instead of forming a single lamina, present a double one. The upper lamina of the verticil is formed of united bracts, deeply incised at the margin, which thus becomes serrate, the serrations agreeing in number with the bracts. This lamina then assumes an inverted umbrella-like appearance and naturally corresponds to the young state of Schimper's single verticillate lamina. The wedge-shaped and sporangiophore-bearing bracts, Schimper's mature state, according to Weiss, form second laminæ *below* the above. He describes the cicatrices on these bracts as four in number—two before and two behind the transverse furrow—and corresponding to the points of insertion of four discoidal sporangiphores. In other words, the upper or inverted umbrella-like verticil is sterile; the lower or horizontal, fertile.

These peltate organs in our specimens do not appear to have any connection with the peculiar bodies figured by Mr. Seward‡ as possibly connected with *Phyllotheca*.

* Traité Pal. Vég., 1874, III, p. 460.

† Abhandl. Geol. Specialkarte Preuss, 1876, II, Heft 1, p. 88.

‡ Cat. Mesozoic Plants Brit. Mus., 1894, t. 1, f. 7.

IV.—Relations with Phyllotheca and Cingularia.

Our plant remains, omitting the peltate verticillate organs, are to all intents and purposes *Phyllotheca*, agreeing with the latter in all other particulars, and approximating closely to *P. Hookeri*, McCoy. So far as I am aware, no such organs have ever been figured in connection with *Phyllotheca*, and there is in consequence only one of two logical conclusions we can come to—either that these peltate verticillate organs are an advance on the structure of the genus in question, or we are dealing with a plant new to Australian Palæobotany, but possessing many of the features of *Phyllotheca*.

The resemblance between the organs in question and the sterile bracts of *Cingularia*, following Weiss, is very marked. Here, however, the resemblance ceases, for, supposing our plant to be allied to the latter, it is very strange that amongst the large number of examples collected by Mr. Henson, not a vestige of a fertile bract, assuming them to be of this nature for the sake of argument, has come under notice, either underneath the sterile bracts or casually on the surface of any of the shale hand-specimens. At the same time, this is simply on a par with some of Weiss's figures, in which he illustrates spikes made up of the fertile bracts, and none of the sterile. Yet, again, in most of his illustrations fragments of one or the other are found lying in contiguity to the parent specimen. Such is not the case, however, in our specimens, and under the circumstances it appears idle and out of place to refer our remains to *Cingularia* pure and simple.

This opens up the question,—Under what name are these organs to be described?—leaves, or a structure accessory to fructification. In the light of *Cingularia*, one would be inclined to accept the latter solution. On the other hand, from what is known of the fruiting of *Phyllotheca* in other parts of the world—bearing in mind no Australian form has been *satisfactorily* described in this condition—due weight must be given to the former supposition.

McCoy was, I believe, the first to draw attention* to a possible inflorescence in *Phyllotheca*, and this is the only Australian instance known. He describes a portion of a branch, having the sheaths "fringed on their upper margin with a dense little whorl of (I think two-celled) anthers." Schimper,† strange to say, ascribes to McCoy quite an erroneous statement, to the effect that the "fructifications (d'après McCoy) semblable à celles des *Equisetum*." As a matter of fact, McCoy's reference was to the male flowers of *Casuarina*. In McCoy's illustration there is certainly a general resemblance to the fructification of *Annularia* given by Renault‡, in which the sporangiophores are represented midway between the nodes. Bunbury also considered§ that the "catkin" figured by McCoy was allied to that of *Asterophyllites* and *Annularia*.

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* Ann. Mag. Nat. Hist., 1847, XX, p. 155.
† Zittel's Paléontologie. Pt. II, Paléophytologie (French Edit.), p. 157.
‡ Cours de Bot. Foss., 1882, II, t. 21, f. 1.
§ Quart. Journ. Geol. Soc., XVII, p. 338.

Zigno says* that the inflorescence of *Phyllotheca* is verticillate at the extremities of the branches, and believes that McCoy's figure recalls much more the amentum of an *Equisetum* than the flowers of a *Casuarina*.

Schmalhausen again differs from McCoy in the interpretation of the Australian fossil. At the same time Schmalhausen figures† three entirely different kinds of fructification ascribed to *Phyllotheca deliquescens*, Goeppert. One‡ is spikelike. A third§ representation is also given by Schmalhausen of a totally different character. Count Solms-Laubach,‖ in criticising these figures, remarks of the second¶ that it represents organs on the internodes situated between the sheaths like the sporangiferous peltate discs of *Equisetum*. He appears to consider the third in much too bad a state of preservation to permit an opinion to be passed upon it. The Count adds:—"Since the specimens have both of them the characteristic foliar sheaths of Phyllotheca, it seems unreasonable to doubt whether they belong to that genus, which would thus differ from true Equisetaceæ in having its fertile spikes repeatedly interrupted by ordinary vegetative leaf-whorls."

The late Prof. Heer figured** the inflorescence of his *Phyllotheca sibirica* in the form of spikes, in the first instance apparently with justification. Count Solms-Laubach says that two others,†† from their association with the remains of *Ginko*, Heer thought were like those of that genus, but the former writer‡‡ believes that Heer is not justified in that view, from mere association.

Lastly, speaking§§ of *Phyllotheca*, Renault says that the spike is verticillate, and the sporangia arranged under peltate bracts; but I do not know his authority for this statement.

The foregoing quotations will at once indicate on what an unsatisfactory basis the evidence of fructification in *Phyllotheca* rests, and that with the exception of McCoy's figure nothing whatever is at present known of that of the Australian forms. His illustration certainly differs widely from either Schmalhausen or Heer's conception of this portion of the plant. That the former has figured more than one kind of fructification under this name is, I think, unquestionable, a fact that also appears to have struck Prof. Heer.‖‖

After all, to us in Australia, *Phyllotheca* is at present little more than a generic name applied to jointed, and more or less costate, stems and branches, the latter springing from above the stem-joints, and bearing linear, verticillate leaves, with a central vein, free distally, but joined into a sheath proximally, and either erect or

* Flora Foss. Form. Oolithicæ, I, pp. 54, 56.
† Jura Flora Russlands, 1879, Pt. I, t. 1, f. 3 and 17; Pt. 3, t. 9, f. 16, 16*a*.
‡ *Loc. cit.*, t. 1, f. 3.
§ *Loc. cit.*, t. 9, f. 17.
‖ Fossil Botany, 1891. English Ed. by Garnsey and Balfour, p. 181.
¶ Schmalhausen, *loc. cit.*, t. 9, f. 16, 16*a*.
** Beiträge Foss. Flora Sibiriens, &c., 1878, Pt. I, t. 1, f. 15.
†† Flora Foss. Aretica, VI, t. 1, f. 5.
‡‡ Fossil Botany, *loc. cit.*, p. 181.
§§ Cours Bot. Foss., II, p. 146.
‖‖ Flora Foss. Aretica, VI, p. 9.

reflexed. As the name *Phyllotheca* was originally described from Australian material, it follows that the genus must derive its distinctive characters from such, and whatever the fructification eventually proves to be, so will Foreign species fall within it, or be relegated to other genera. Following Weiss's conception of *Cingularia*, it may perhaps be deduced that the peltate organs from our Upper Coal-Measures are but the sterile bracts of *Phyllotheca*. At the same time the imperfect evidence at command does not warrant a decided opinion. All that we can say with certainty is, that these bodies are in this instance associated with other remains that we have been accustomed to regard as those of *Phyllotheca*, to the exclusion of any other plant-remains, except leaves of *Glossopteris*. The general appearance of Mr. Henson's specimens would lead one to relegate them to *P. Hookeri*, McCoy.

With the exception of Weiss's figures of *Cingularia*, the only other figure known to me at all like the peltate organs from our Upper Coal-Measures is one given by Fontaine in his "Potomac or Younger Mesozoic Flora,"* although much smaller in size, that he considers may possibly be a sheath of an *Equisetum* compressed vertically. It possesses most of the characters exhibited by our specimens.

To sum up, the following points are worthy of being noted:—

1. In world-wide *Phyllothecæ* there have been at least three forms of fructification described.
2. With the exception of McCoy's figure, the fructification of Australian species is unkown.
3. In our Upper Coal-Measures occurs a plant, to all intents and purposes a *Phyllotheca*, possessing peltate organs identical in structure with the sterile bracts of *Cingularia*.
4. This plant seems to be closely allied, if not identical, with *Phyllotheca Hookeri*, McCoy.

XXVII.—On some Rock-Specimens from the Auriferous Granite at Timbarra: by GEORGE W. CARD, A.R.S.M., F.G.S., Curator and Mineralogist.

OWING to the exceptional interest pertaining to the occurrence of gold in granite, the results obtained by the Author in examining a small collection of rocks from the Timbarra Gold-fields may not be unworthy of record.

This collection comprises a series of granites and eurites collected by Mr. Thomas Horton, and submitted for examination to the Geological Survey Branch.

* Mon. U.S. (Powell's) Geol. Survey, 1889, XV, Atlas, t. 173, f. 11, 11a.

The Timbarra Gold-fields are situated on a granite table-land four hundred and ninety miles north of Sydney and twenty miles south of Tabulam. A general geographical description of the district will be found in the first volume of these Records, pp. 43, *et seq.* Where the granite has become soft by atmospheric weathering it is excavated for sluicing. Any undecomposed portions are left standing in large masses. The free gold is very fine, but as much as five pennyweights of gold to the ton is said to have been saved by sluicing decomposed portions of the granite when containing pyrites. Assays of similar stone yield gold at the rate of nine pennyweights. The granite is traversed by a few small veins of auriferous quartz.*

The series comprised fifteen specimens of granite and eurite, the former coming from Surface Hill, Timbarra, and the latter principally from a dyke five miles further west.

The numbers attached to the descriptions are those under which they are registered in the Departmental Collections. The numbers in square brackets refer to the micro-slides.

Although not all gold-bearing themselves, Nos. A 244 to A 251 are described as coming from auriferous areas.

A 244 [574]. Country Rock, at Surface Hill. A pink granite of medium grain, unaltered and quite normal in character. The minerals present are quartz, felspar, and mica; the latter not very abundant. Quartz is abundant, and is traversed by the usual lines of enclosures. The felspar is clouded. With the exception of a few crystals, it is all simply twinned.

A 245 [577]. From Surface Hill. An unaltered flesh-coloured granite. The weathered side of the specimen is constituted by a vein of quartz, in the cavities of which are imbedded little nests of molybdenite. The minerals present are quartz; felspar, much clouded, a good deal of it repeatedly twinned; and certain alteration products which may represent mica. The glass inclusions in the quartz contain fixed bubbles of large size. On assay it yielded—Gold 18 dwt. 8 gr. per ton; silver, 3 dwt. 6 gr. per ton.

A 246 [578]. From Surface Hill. A much decomposed but coherent granite. The specimen is about one and a half inches thick, and is bounded by parallel sides. It is traversed obliquely by a vein of translucent quartz. This vein is very irregular and contains mica; the average width is three-quarters of an inch. The constituents are quartz, and orthoclase and plagioclase felspar. The felspar is much clouded, and has partially recrystallized. On assay it yielded neither gold nor silver.

* Further details will be found in the Ann. Report Dept. Mines N. S. Wales for 1889 [1890], pp. 201, 202.

A 247. From Surface Hill, from a depth of twenty feet. A very crumbly granite. It contains quartz, pale flesh-coloured felspar, still retaining a slightly vitreous lustre, and a few crystals of dark-green mica. Much pale-green soft material occurs with the products of decomposition of the felspar. On assay it yielded neither gold nor silver.

A 248. From Surface Hill, from a depth of one hundred feet. A crumbling, somewhat fissile granite, the divisional planes being coated with white decomposition products. It consists of quartz; felspar, kaolinised, but with the lustre not altogether lost; dark-green mica; and greenish material, as in A 247. On assay it yielded neither gold nor silver.

A 249. From Surface Hill, from a depth of twenty feet. A pink-coloured rotten granite, consisting of quartz, decomposed felspar, and greenish mica. On assay it yielded—gold, 4 dwt. 8 gr. per ton; silver, 2 dwt, 4 gr. per ton.

A 250. From Surface Hill, from a depth of one hundred feet. A pink somewhat crumbly granite. It consists of quartz, and felspar simply twinned, considerably decomposed, but with its lustre not much impaired. On assay it yielded neither gold nor silver.

A 251 [567]. From Surface Hill. A dull-pink unaltered granite. It consists of quartz; orthoclase, and plagioclase in smaller crystals, both considerably altered; and patches of a pleochroic green substance that may perhaps represent mica. On assay it yielded neither gold nor silver.

A 252. From Surface Hill. A very crumbly, white, fine-grained granite or eurite. The felspar is much decomposed, and but little or no mica is present. This rock is described by the sender as a dyke cutting across the belts of auriferous granite without fault. The granite is said to be auriferous only to the north of it, although its character is the same on each side. On assay it yielded—gold, 7 dwt. 14 gr. per ton; silver, 3 dwt. 6 gr. per ton.

A 253 [575]. From Surface Hill. Country rock similar to A 250. Much plagioclase is present, both it and the orthoclase being much altered. A little greenish mica occurs, together with greenish earthy decomposition products. On assay it yielded neither gold nor silver.

A 254 [576]. From Surface Hill. Similar to A 253, but somewhat more coarsely crystallized. On assay it yielded neither gold nor silver.

A 255. Pegmatite from a dyke five miles west of Timbarra, consisting of quartz and pink orthoclase associated pegmatitically. On assay it yielded neither gold nor silver.

A 256 [595]. Adjoining A 255, from the same dyke. A pale cream-coloured eurite containing nests of a sulphur-coloured micaceous mineral and of arsenical and iron pyrites. The felspar is so far decomposed as to give rise to a white powder where the rock is bruised, and is much iron-stained. The quartz and felspar are graphically associated. On assay it yielded neither gold nor silver.

A 257. Adjoining A 256, from the same dyke. A cream-coloured eurite with nests of a greenish-yellow mica. Two assays* were made which yielded respectively:—

1.	Gold	2 oz. 12 dwt. 6 gr.	per ton.
	Silver	15 ,, 2 ,,	,,
2.	Gold	5 ,, 10 ,,	,,
	Silver	2 ,, 4 ,,	,,

No gold was visible in this or any of the specimens.

A 258. Adjoining A 257. A eurite in which blebs of quartz are embedded in a matrix earthy-white where bruised, otherwise greenish yellow. Nests of white mica and of a greenish-yellow micaceous substance and of arsenical pyrites occur. With the microscope a tendency to micropegmatitic structure is noticeable; the mica is seen to occur in wisps, and the felspar is to a large extent replaced by a somewhat fibrous doubly-refracting substance. On assay it yielded neither gold nor silver.

Only four of these specimens were auriferous in themselves, although others were described as coming from auriferous areas. To summarize the results:—

A 245. Unaltered granite; Surface Hill. (A vein of quartz carrying molybdenite present):—

Gold	18 dwt. 8 gr.	per ton.
Silver	3 ,, 6 ,,	,,

A. 249. Rotten pink granite; Surface Hill. Depth, 20 feet:—

Gold	4 dwt. 8 gr.	per ton.
Silver	2 ,, 4 ,,	,,

A 252. Very crumbly eurite. Dyke cutting the auriferous granite without fault:—

Gold	7 dwt. 14 gr.	per ton.
Silver	3 ,, 6 ,,	,,

A. 257. Cream-coloured eurite, from a dyke five miles west of Timbarra:—

1.	Gold	2 oz. 12 dwt. 6 gr.	per ton.
	Silver	15 ,, 2 ,,	,,
2.	Gold	5 ,, 10 ,,	,,
	Silver	2 ,, 4 ,,	,,

The rocks represented by these specimens are thus seen to consist of a normal granite, generally pink or flesh-coloured, traversed by a eurite dyke at Surface Hill and a eurite dyke passing into pegmatite five miles to the west. Of the four specimens that were auriferous two were eurites, a third rotten granite, and the fourth an unaltered granite. These assays would not therefore appear to afford any clue as to what description of stone is most likely to carry gold.

* In every case the assay samples were taken by chipping corners off the specimens. In this case the second assay was made on a freshly-chipped sample.

It will be seen from the descriptions that the granite consists essentially of quartz and flesh-coloured felspar; mica and accessory minerals being rare. Triclinic felspar is common [*See* Nos. A 244, 245, 246, 251, 253]. It would thus come under the old term "binary granite," and approximate to the "aplites" and "granitites" of some authors. There does not, however, appear to be any need for a distinctive name. The dyke rocks, consisting of very fine-grained granites, can be classed as eurites.

Questions have been raised locally as to whether the granite may not be of metamorphic origin. There do not appear to be any indications in favour of such a theory. The assays were made in the Departmental Laboratory under the supervision of Mr. J. C. H. Mingaye, F.C.S.

XXVIII.—Petrological Notes on two Andesites associated with Auriferous Deposits in N. S. Wales: by J. B. JAQUET, A.R.S.M., F.G.S., Geological Surveyor.

[Plate XX.]

THE specimens of one of the andesites I obtained from the walls of the Bushman's Hill Mine, which is situated about a mile from Parkes, in a northerly direction. The igneous rock occurs here as a large dyke intruding indurated slates of Silurian age.

The reef exploited by this mine has recently been yielding some very rich ore. During the past three years, while worked on tribute by a party of miners, 2,899 tons of ore containing 8,380 oz. of gold have been raised from it. The vein varies in width from ten inches to two feet. It is composed essentially of quartz with some iron pyrites. The gold which it yields is coarse, and the greater portion of it readily amalgamates in the mortar and on the battery plates.

The walls are smooth and slickensided, and the fissure which preceded the reef has without doubt been formed along a line of faulting; hence we may expect the reef to be permanent and not pinch out when followed downward. When hitherto exposed, the walls are chiefly composed of andesite, but also in places of slate.

The mean of several determinations for the specific gravity of the andesite gave it as 2·82. It breaks with a subconchoidal fracture, and possesses a greyish green colour. The numerous hornblende idiomorphs can be seen with the naked eye, and are easily distinguished by the aid of a hand-glass.

When examined in thin sections under the microscope, the rock is seen to consist of crystals of triclinic felspar and hornblende with grains of magnetite imbedded in a cryptocrystalline ground mass. Minute veins of calcite occur in places. The felspars are much kaolinised, and in many instances have been entirely replaced by a mosaic of quartz granules with some calcite. One of these altered crystals is figured upon the plate accompanying this paper (Pl. XX, Fig. 3.)

The specimens of the other andesite were collected near the Old Copper Mine, about a mile and a half west of Blayney.

The rock occurs as a large boss intruding Silurian slates. A considerable amount of copper has been won from a lode running through it; and in 1892 a rich patch of alluvial gold which, without doubt had been derived from a reef close at hand, was discovered in clay resulting from its decomposition.

Particulars concerning this gold deposit will be found in my report written at the time of the discovery.*

The rock has a specific gravity of 2·88, and possesses a greenish colour. When examined by the naked eye dark augite idiomorphs are seen standing out prominently from a lighter base.

Under the microscope it is found to consist of crystals of triclinic felspar and augite with magnetite grains imbedded in a cryptocrystalline base. The felspar crystals are lath-shaped and much kaolinised. The augite crystals are frequently twinned, and a number of them are more or less altered into chlorite. In other places this mineral has passed into uralite; good examples of this paramorph are to be seen, one of which is figured upon the plate accompanying this paper (Pl. XX, Fig. 1.)

Uralite has been previously noted as being present in some of the andesites found in the southern portion of the Colony by my late Colleague, Mr. W. Anderson.†

The Rev. J. Milne Curran, has described an "augite porphyrite," which he obtained in a cutting near the Roman Catholic Church at Blayney; but the particulars which he gives shows it not to be identical with rock occurring near the Old Copper Mine, and described above.‡

Andesitic rocks would seem not infrequently to accompany the auriferous deposits in New South Wales. I found in looking through the collection of rock-sections belonging to the Geological Survey, a hornblende-andesite from Sofala, an augite-andesite from the Wentworth Proprietary mine at Lucknow, and a pyroxene-andesite from Mitchell's Creek, near Wellington.

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* Ann. Rept. Dept. Mines and Agric. N. S. Wales for 1893 [1894], p. 120.
† Records Geol. Survey N. S. Wales, 1894, II, Pt. 4, p. 141.
‡ Journ. R. Soc. N. S. Wales, 1891, XXV, p. 221.

XXIX.—An undescribed Coral from the Wellington Limestone, N. S. Wales: by R. ETHERIDGE, Junr., Curator of the Australian Museum.

[Plates XXI—XXII.]

A VERY characteristic coral occurs in the Cave Limestone at Wellington, that appears worthy of description. Its appearance alone is exceedingly noteworthy, as the form presents some very instructive examples of calicinal gemmation in single buds. It is very closely allied to *Tryplasma æquabilis*, Lonsdale,* and for it I propose the name of *T. wellingtonensis*.

The corallum in the earlier stages is short turbinate-conical, with a few anchoring rootlets at the extreme base, that did not extend upwards as the coral grew; nor are there any connecting processes with other individuals—the corallum is, therefore, simple, and neither aggregate, nor composite. The immediate base is sometimes slightly expanded as if forming a base of attachment. As the corallum grew it became more cylindrical and less turbinate, often twisted, and, in a few instances, bent upon itself (Pl. XXI, Fig. 2).

Budding took place from the inner rim or margin of the calice, the new corallite either continuing its upward growth from the attenuated base, or, at once rapidly expanding, soon filled the parent calice. In one specimen (Pl. XXI, Fig. 1) the latter continued its growth under the former condition, and ultimately united with the outer surface of its offspring.

The wall is moderately thick, and was probably surrounded by an epitheca. I say probably, because the outer surface of the whole of the specimens has become so entirely converted into beekite, that it is difficult to state with certainty what its precise condition was. The calice seems to have been deep, and fairly straight-walled.

The septa are marginal and lamellar in the first instance, very short, of two orders, alternately large and small, and all terminating on their inner edges in free denticles that project into the visceral cavity, or intertabular spaces, as the case may be (Pl. XXII, Figs. 1 and 4). The greatest number of septa counted in any portion of one calice is thirty, but this number only represents a portion, and there are, in all probability, quite fifty. No opportunity having arisen of examining an absolutely unoccupied, or on the other hand, perfect calice, this

* Murchison's Geology of Russia, 1845, I, t. A, f. 7.

number even is open to emendation. No trace of a fossula has been observed, nor any superiority in size or length, beyond the division into two orders of one septum over another.

The tabulæ are very numerous, thin and delicate, close together, or widely separated, complete or incomplete, horizontal or oblique, either extending wholly across the corallum, or coalescing with one another, and in the latter case enclosing irregular, or subvesicular, intertabular spaces (Pl. XXII, Fig. 1). The tabulæ do not merely reach from septum to septum on the same level, as described by Dybowski in his genus *Acanthodes*, but unite with the walls on opposite sides, and assist in supporting the general structure (Pl. XXI, Fig. 5; Pl. XXII, Fig. 1). They have a rolling surface, and naturally from the form of the septa there is no extension of these structures on them, nor is there the slightest appearance of a columella.

There are no accretion rings in the strict sense of the word, but the apparent presence of these is caused by the edges of old calices, where a younger corallite has grown rapidly within and then completely infilled it (Pl. XXI, Fig. 1). At times a small space is left between the two, in which the tooth-like septa are just visible (Pl. XXI, Fig. 4). In all cases where the calice has not been filled by a younger corallite it will be found in mature examples, to be deep, straight-walled, and the bottom formed by the youngest tabulum, and usually uneven from the rolling nature of the latter.

In a young shallow example that has just expanded, and attained no height (Pl. XXI, Fig. 8), the septa cover nearly the whole surface, some lamellar, the others consisting only of a series of points.

In Pl. XXI, Fig. 6 a very interesting specimen is depicted. The wall has been removed by natural disintegration together with the septa. The latter are now represented by a series of pits in vertical rows, and the interseptal loculi by the intervening ridges. Lonsdale figured an example of his *Tryplasma æquabilis** in a similar condition. As I have previously pointed out,† it was probably this condition that induced Lonsdale to believe that the septa were pierced "from the inner surface of the wall, through the whole breadth, by well defined relatively large foramina".‡ Indeed his figure of *T. æquabilis* is perfectly in accord with our specimen (Pl. XXI, Fig. 6), exhibiting the decorticated or weathered longitudinal section. Furthermore, in Lonsdale's figure, the tabulæ are continued from wall to wall. The structure of this specimen entirely bears out the explanation I have previously suggested of this phenomenon.

* Murchison's Geology of Russia, 1845, I, p. 613, t. A, f. 7.
† Records Geol. Survey N.S. Wales, 1890, II, Pt. 1, p. 17.
‡ Lonsdale, *loc. cit.*, p. 613.

I have not seen the slightest trace of any epithecal scales, rhombic or otherwise. On account of the silicification of these corals, and the conversion of the entire outer surface into beekite, it is even difficult to distinguish the presence of costæ. I have, however, seen a trace of them in one specimen. The surface of the Wellington corals is covered by prickles, but these are the central points of the beekite rosettes, and not in the slightest degree epithecal structures. I have already figured* similar rosettes, with an elevated central point, in other corals from Wellington, and the prickle-like elevations partake of the same nature.

In a coral with such remarkably short and distally free septa dissepiments would not be expected, but at times a single dark plate is developed. In the horizontal section (Pl. XXII, Fig. 5) of a portion of the wall, prepared for the microscope, this ring is displayed. It is, in all probability, not formed by a series of dissepiments in a single line, but is the primitive theca in the substance of the outer investment, and septa traversing this zone have an intra- and extra-thecal portion. In a rather more complete section (Pl. XXII, Fig. 2) an inner ring is visible which might be taken for a further series of dissepiments,—it is however, a second corallite springing from within the older one. This is at once apparent from the fact that the septa of the older and outer calice are seen to pass over this wall and be above those of the inner and lower calice.

The septa are thorn-like thickened bodies, quite homogenous (Pl. XXII, Fig. 4), and without any trace of primordial septa. In the vertical section (Pl. XXII, Fig. 1) the septa appear to be composed of concentric layers of stereoplasma. On the upper left-hand portion of this section are several septa, transversely cut, projecting inwards from another portion of the wall. On the lower left-hand side are the free ends of septa extending from the wall into the intertabular spaces (Pl. XXII, Fig. 4).

The vertical section also shows that the tabulæ unite with the wall, and are thickened. Their irregularity and frequent incompleteness is also shown, often coalescing with one another and enclosing spaces that almost give rise to a vesicular appearance.

The specimens were collected at Wellington by Mr. W. Anderson, late of the Geological Survey of New South Wales, Mr. P. T. Hammond, Field-Assistant, and Mr. J. Sibbald, Keeper of the Wellington Caves. The specimen from the Jenolan Caves was obtained by Mr. J. C. Wiburd, Guide.

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* Rec. Austr. Mus., 1893, II, No. 5, p. 76, t. 16, f. 4.

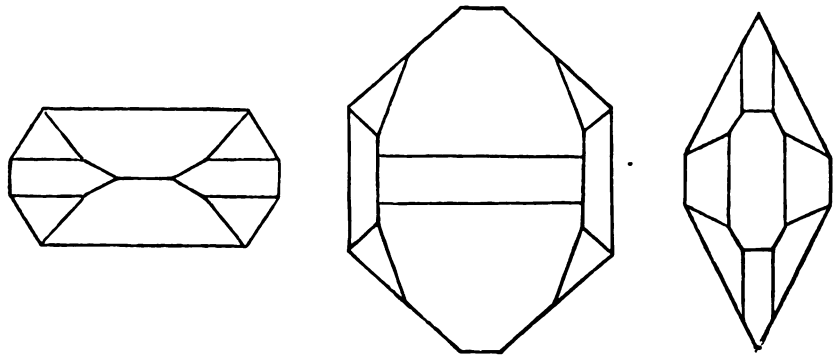
XXX.—On a Supposed Sulpho-carbonate of Lead, from the Australian Broken Hill Consols Mine, Broken Hill: by P. T. HAMMOND, Field Assistant.

THE specimen which forms the subject of this paper was presented to the Government Geologist by Mr. G. Smith, the General Manager of the Consols Mine.

It is of irregular outline, measures eleven and a half inches by eight inches across, and consists of a mass of crystals ranging from about an eighth of an inch or less to half an inch in length, seated on cerussite, which is for the most part in fine acicular crystals, though in parts massive. The specimen has also a few arrow-head-shaped twins of the same mineral on its surface, and is more or less intimately mixed with it throughout the whole mass, rendering it an exceedingly difficult matter to obtain a pure sample for assay, the two minerals being similar in colour and nearly alike also in lustre. A few specks of galena also occur throughout the mass, and the side which has been attached in the lode is partly coated with the same mineral.

Crystallographic System.—Rhombic, some crystals having the appearance of being monoclinic, owing probably to twinning or to the unequal development of opposite pairs of faces. The crystals examined exhibited faces of the right rhombic prism ∞P, variously modified by faces of the right rhombic pyramid m P, the macropinakoid $\infty \bar{P} \infty$, the brachypinakoid $\infty \breve{P} \infty$, macrodome $m \bar{P} \infty$, and brachydome $m \breve{P} \infty$.

Faces of a second rhombic prism of different angle are also observable in some crystals.



(The above figures are sketched, measurements of the angles not having been obtained.)

Physical Characteristics.—Cleavages imperfect. Colour from white to colourless, transparent to translucent. Lustre vitreous on the faces of the crystals, adamantine to resinous on fractured surfaces. Striations on faces very exceptional. Brittle and with an irregular fracture. Hardness = 3. Streak, white. Specific gravity= 6·22—6·33.

Composition.—Two analyses were made (the first in duplicate) by Mr. J. C. H. Mingaye, F.C.S., of samples picked with great care, with the following results: —

Analysis No. 1.

	1	2
H_2O	nil.	nil.
PbO	74·11	74·09
SO_3	22·27	22·23
CO_2	3·32	3·36
	99·70	99·68

The second sample was picked for analysis with a view of determining whether the percentage of CO_2 remained sufficiently constant to warrant either the formation of a new species, or the classification of the mineral as a variety of a previously established sulpho-carbonate, as an examination with the blowpipe and commoner reagents had already indicated the presence of SO_3 and CO_2.

Analysis No. 2.

PbO	74·11
SO_3	25·00
CO_2	1·34
	100·45

It will be seen from an examination of these analyses that there is not only considerable variation in the percentage of CO_2 in the mineral, but also that the percentage is not high in either of them.

Reaction before the Blowpipe, &c.—Fuses easily in a candle flame with a little decrepitation to a clear globule which becomes opaque on cooling, or in part turns, at first yellow, then orange red or brownish yellow, becoming again yellow on cooling. If the heat be increased it fuses to a metallic bead of lead. On charcoal yields a metallic bead with a yellow incrustation, which turns white on cooling. Fused with carbonate of soda on charcoal, and placed with water on a silver coin, blackens the silver. Effervesces in warm hydrochloric acid.

Difference from hitherto described Sulpho-carbonates.—Dana classifies all the known sulpho-carbonates of lead under one species, Leadhillite, which is described as monoclinic in his "System of Mineralogy," 1892, although described as "orthorhombic," though "monoclinic in aspect" in the earlier editions of the

same work, which he attributes to hemihedrism in some of its planes. It is also described as having one perfect cleavage, and the laminæ are said to be flexible. The mineral under examination is, I think, undoubtedly rhombic as shown in the figures, although a number of the crystals have undergone very unequal development, thus causing them to assume occasionally a monoclinic aspect. It does not show any perfect cleavages, and, far from being flexible, is extremely brittle. It differs also from leadhillite in the very low percentage of carbon dioxide, containing only 3·36 per cent. as against 7·98 to 12·12, which is the range of the various analyses given by Dana, and in the second analysis made it is even lower, being only 1·34.

It differs also in its superior hardness, leadhillite being 2·5, whereas the Broken Hill mineral is 3; another difference, as pointed out by the Government Geologist, is the anhydrous condition of the latter, as leadhillite contains from 1·5 to 2·70 of water.

Of Lanarkite, which was formerly described as a sulpho-carbonate by Brooke,* Bauerman says:—† "This was formerly regarded as containing equal molecules of sulphate and carbonate of lead; but late researches by Flight and Pisani have explained away the carbonate, and make it consist of Pb. SO_4 Pb. O, or Pb. SO_4, 57·6, Pb. O, 42·4," and Dana‡ gives five analyses by Flight, Pisani, and Collie, none of which show the presence of CO_2; nevertheless, as our mineral contains so low a percentage of CO_2, as barely, if at all, to remove it from the sulphates, a comparison with this species may not perhaps be considered superfluous. Lanarkite differs from it in being monoclinic in form, in having one perfect cleavage, in being flexible in thin laminæ, and in its inferior hardness,=2 to 2·5, which is about equal to that of leadhillite.

Susannite is classed by Dana as a variety of leadhillite, and does not differ materially from that species in its physical or chemical properties.

Caledonite, a cupreous sulpho-carbonate of lead, needs only passing mention here, as the Broken Hill mineral has not been found to contain copper.

Affinities.—Both in its crystallographic form, and in its physical properties, and behaviour before the blow-pipe, the mineral under examination agrees closely with anglesite (sulphate of lead), and appears to differ from that mineral only in the presence of, at most 3·3 per cent. of carbon dioxide.

The crystalline form of some of the crystals agrees very closely with a figure given by Bauerman§ for anglesite, where he also remarks, "The crystalline forms of anglesite are of especial interest as showing the amount of variation of

* Brooke, Edin. Phil. Journ., 1820, III, p. 117 (*fide* Dana.)
† Descriptive Mineralogy, 1884, p. 303.
‡ Dana, System of Mineralogy, 1892, p. 923.
§ Descriptive Mineralogy, 1894, pp. 289, 291.

character possible in substances of rhombic symmetry," and, further, that it has been observed in "thirty-one forms and one hundred and seventy-eight combinations," so that it is not surprising if the crystals examined do not exactly conform to previously figured ones.

Anglesite has been recorded for New South Wales by Prof. A. Liversidge, M.A., F.R.S.,* as occurring at the Abercrombie River, at Silverton, at South Wiseman's Creek, and at Severn River, and by Mr. J. B. Jaquet, A.R.S.M, &c.,† in small quantities on the upper portion of the Thackaringa Lode.

Conclusions.—As the percentage of CO_2 is so low in this mineral, and taking into consideration the close resemblance in crystallographic form and physical properties to anglesite, I would suggest either that it is a variety of that mineral, or as seems to me the more probable solution, that the CO_2 is to be accounted for by the penetration of small crystals of cerussite into the crystals of anglesite, as, owing to the similarity of the one to the other; and their intimate admixture, they would be very easily overlooked, though the sample might be chosen with the greatest care. Another possible solution is that the mineral may be in the transition stage from anglesite to cerussite, for, as Rutley says,‡ cerussite "may result directly from the decomposition of anglesite by water charged with bicarbonates."

I would, therefore, submit that that the mineral is not a new species, but that it is a specimen of anglesite intimately associated with cerussite, this intimate association would sufficiently account for its somewhat anomalous behaviour before the blowpipe.

Another specimen from Block 10 Mine, Broken Hill, measures five inches each way, and consists of a mass of small crystals of anglesite, (none of which exceed, and few attain to a quarter of an inch in length) grouped in branching forms on cerussite, which is in part massive, and in part consists of fine acicular crystals. This, in turn, rests on a spongy semi-crystalline mass of galena, which exhibits plain evidences of decomposition, and subsequent removal of much of its substance; this, as in the former case, is the side of attachment.

The crystals are of a greyish tinge, are very irregularly developed, and for the most part conform to the description given for the specimen from the Consols Mine; but although no striations are visible on the crystals, the faces in $\breve{P}\infty$ have in all cases a frosted or roughened appearance, which is not seen in the previously described specimen.

In physical properties and reactions with the blowpipe, &c., the two specimens are identical.

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* Minerals of N. S. Wales, 1888, p. 64.
† Geology of the Broken Hill Lode (4to. Sydney, 1894, by Authority), p. 113.
‡ Rutley, Elements of Mineralogy, 1887, p. 194.

XXXI.—On additional Aboriginal Rock-carvings on the French's Forest Road, near Bantry Bay: by W. S. DUN, Assistant Palæontologist.

[Plates XXIII and XXIV.]

IN 1890, Mr. R. Etheridge, Junr., described* a set of Aboriginal Carvings occurring on a surface of the Hawkesbury Sandstone at the side of the French's Forest Road, Parish of Manly Cove, County of Cumberland. This locality is on Reserve 41, about three and a half miles from the Spit. The exact position of the carvings is shown on Plate XXIII. It is not my intention to discuss the relations and affinities of the designs, as these have already been so successfully performed by the above-mentioned Writer, but merely to record the uncovering of some additional delineations and figure them for future reference and comparison.

Towards the end of last year the scrub and a thin coating of soil were cleared off portions of this table of rock, under the supervision of Mr. W. S. Leigh, Superintendent of Caves, and by these means the additional outlines were brought to light. As was the case in the formerly described ones, these are very faintly marked and difficult to trace.

II.—Description of Figures.

Three figures in their relative positions are shown on Pl. XXIV, Figs. 1, 4, and 5. To the best of my knowledge, no outlines similar to these have been recorded from New South Wales. Fig. 4 appears to show a slight constriction at the upper end, which gives a roughly head-like form to this portion. These two figures may bear some relation to two outlines occurring at Flat Rock, near Manly, and figured, without any remarks by Mr. Etheridge as being within the outline of a large fish.† In juxtaposition to what may be termed the right limb of Fig. 4 is an outline with a rounded head, which becomes constricted, and then continued in a short, wide prolongation. If the proportional length of this portion were only exaggerated, this might be taken to represent some form of club.

Three unmistakable delineations of tomahawks are shown by Figs. 3, 10, and 12. Fig. 3 represents a form in which the head is slightly curved upwards, and the handle is attached to the middle of the head. In Fig. 4 is represented a common form of Aboriginal tomahawk, oblong-ovate in shape and more sharply curved at the cutting edge; in this case the handle is attached to the end. In Fig. 10 is shown an elongate oval and slighted pointed weapon with the handle attached to the middle of the blade.

* Records Geol. Survey N. S. Wales, 1890, II, Pt. 1, pp. 26-35, t. 2.
† Records Geol. Survey N. S. Wales, 1892, II., Pt. 4, t. 16, f. 1.

In Fig. 2 we have the representation of a fish showing the caudal fins only; this is a little over a foot in length. The caudal fins are much more perfectly represented than in the drawing figured in Mr. Etheridge's paper.

An outline of what I think must be taken to represent a foot is shown in Fig. 6. This is one foot eight inches in length and eight inches across at its broadest part; five toes are depicted.

In Fig. 7 we have a long narrow object, three feet eight inches in length and seven inches wide, of doubtful affinity; and in Fig. 8 is a circular outline.

The subject of Fig. 11 is somewhat similar to Fig. 7; it is six feet there inches in length, eleven inches wide, and there is a slight constriction at one end.* This may represent an elongated fish, possibly an eel.

By far the best outline of this new set of carvings is shown in Fig. 9. This is the undoubted representation of a kangaroo, three feet ten inches from the nose to the tip of the tail and one foot six inches high at the shoulder. The ear and a fore and hind limb are shown. The tail has the characteristic thickening at the base very strongly developed. No eyes are shown as in the other drawings of kangaroos at this locality.

A plan is appended to this note, showing the relative position of the site of these interesting carvings to Manly and North Sydney.

XXXII.—The Australian Geological Record for the Year 1894, with Addenda for 1891 to 1893; by R. ETHERIDGE, Junr., Curator of the Australian Museum, and W. S. DUN, Assistant Palæontologist.

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* *Loc. cit.*, t. 2, f. 5, 14.

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PLATE XVII.

Phyllotheca? *sp.*

Fig. 1. Branch, with the remains of six peltate organs.

Fig. 2. Another branch, with portions of four organs, and traces of transverse striation.

Fig. 3. Branch, with a small peltate organ, seen somewhat from below.

Fig. 4. Another example, somewhat larger than Fig. 3.

Fig. 5. Branch, with one organ at the base, and signs of attachment of three others above.

Fig. 6. Denuded branch.

Fig. 7. An organ of large size, compressed from above, showing the spike-like extensions at the periphery, the nerves (?) proceeding to them and the re-entering spaces.

Fig. 8. A smaller organ, compressed from above.

Fig. 9. An organ attached to the branch, the upper half almost in its normal condition, the lower half bent backwards and downwards.

Drawn from nature by Mr. P. T. Hammond.

P. T. Hammond, del.

Heliotype.

PLATE XVIII.

Phyllotheca, *sp.?*

Fig. 1. A stem, exhibiting seven nodes, and indistinct striation.

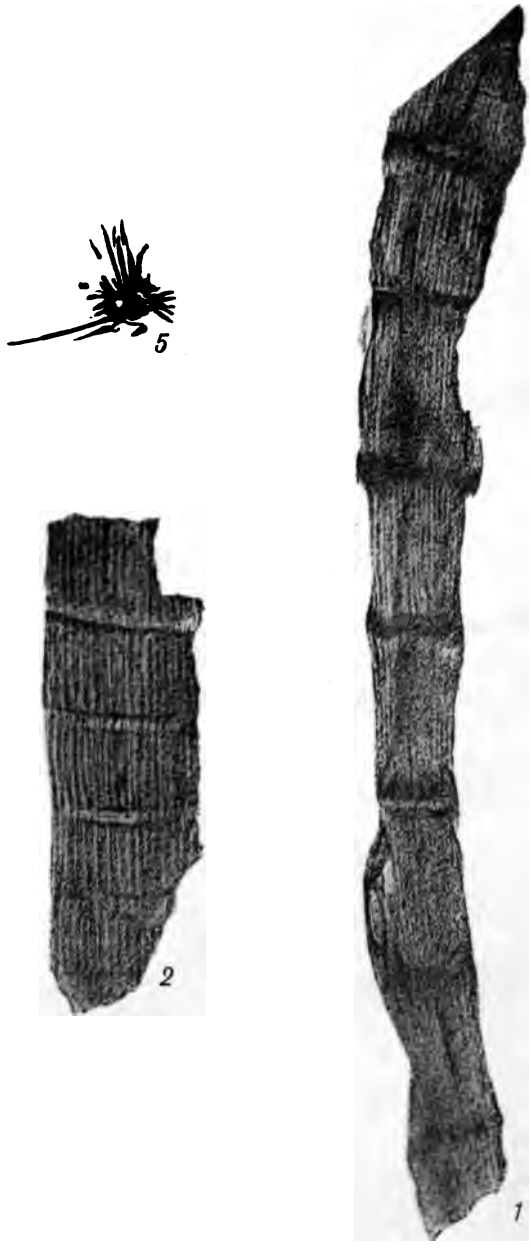
Fig. 2. A broader stem, with five nodes, and the costæ more marked. The internodes are relatively shorter and broader in this example.

Fig. 3. A peltate organ, seen from above, showing the central invagination and spine or tooth-like terminations of the radiating ribs.

Fig. 4. Foliage, around two nodes, the stem being faintly indicated between.

Fig. 5. Foliage, around a node, seen from above.

Drawn from nature by Mr. P. T. Hammond.



P. T. Hammond del. Heliotype.

PLATE XIX.

Plan and sketch section, showing the position of the shale bed at Newcastle, from which the *Phyllotheca?* remains were collected by Mr. J. B. Henson, C.E.

Scale—2 chains to 1 inch.

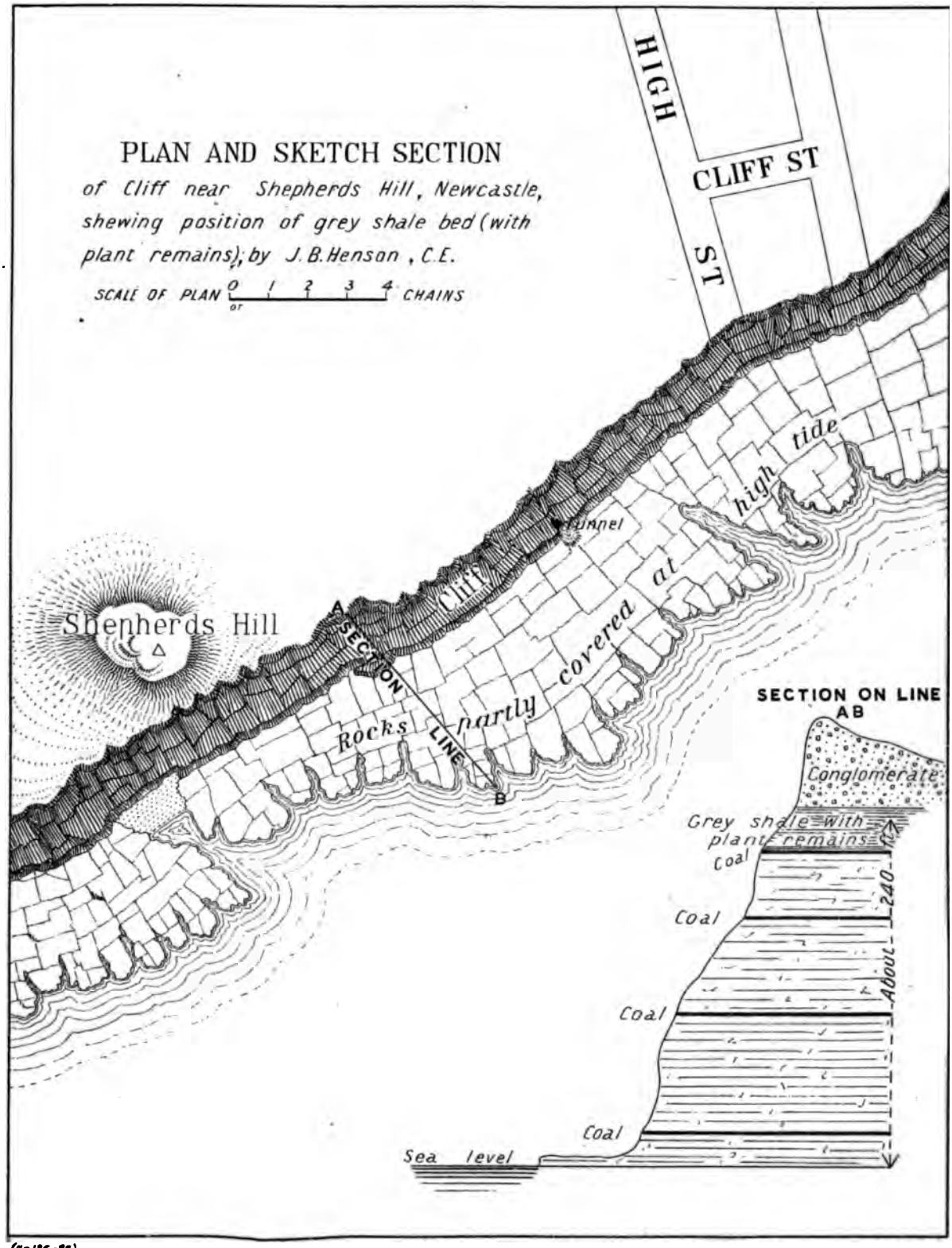


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PLATE XX.

Fig. 1. Crystal of Uralite (augite passing into hornblende), occurring in augite andesite, from Blayney.

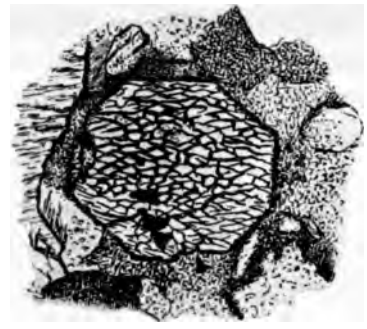
Ordinary light; magnified 35 diameters.

Fig. 2. Hornblende-andesite, from Bushman's Hill Mine, near Parkes.
Minerals represented are hornblende, triclinic felspar, and magnetite.

Ordinary light; magnified 40 diameters.

Fig. 3. Portion of a Felspar crystal, replaced by a mozaic of quartz granules and calcite, from same slide as Fig. 2.

Drawn from nature by Mr. P. T. Hammond.



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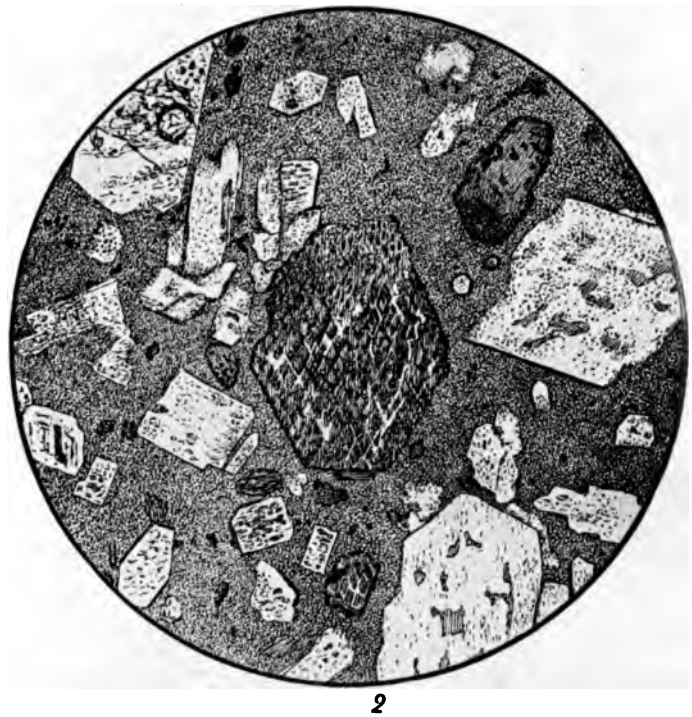

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P. T. Hammond, del.

Heliotype.

PLATE XXI.

Tryplasma wellingtonensis, *Eth. fil.*

Fig. 1. Parent corallum, with a matured bud, the interspace between parent and offspring having been subsequently filled-in by the former. Wellington.

Fig. 2. A much curved corallite. Wellington.

Fig. 3. A more or less straight corallite, showing costæ. Wellington.

Fig. 4. A parent corallite and two buds, the first of the latter almost entirely infilling the original calice. Wellington.

Fig. 5. Natural section of a corallite, exhibiting moderately regular tabulæ, rather more distant from one another than is usually the case, and along the fractured edges the spine-like septa. Jenolan Caves.

Fig. 6. Natural section, highly weathered, with the wall and septa removed, showing the latter represented by small pits, and the inter-septal loculi as ridges. Wellington.

Fig. 7. A somewhat similar specimen to Fig. 6, the lower portion showing like characters, and the upper crushed tabulæ. Wellington.

Fig. 8. Two shallow calices, one within the other, both exhibiting the spine-like septa. The older or outer corallite also displays anchoring rootlets protruding from near the base. Wellington.

Fig. 9. A polished section of a corallite, with irregular tabulæ in the lower part and spine-like septa protruding into the calice in the upper. Wellington.

Drawn from nature by Mr. P. T. Hammond.

2

6

3

1

8

7

4

9

5

PLATE XXII.

Tryplasma wellingtonensis, *Eth. fil.*

Fig. 1. Longitudinal section, prepared for the microscope, displaying the irregular and incomplete tabulæ. At the right-hand upper, and left-hand lower corners are the septa protruding into the inter-tabular spaces; and at the upper left-hand corner are the cut apices of septa projecting from the opposite wall. Wellington. ×2.

Fig. 2. Transverse section of another specimen, similarly prepared, displaying the septa of an older corallite projecting over the wall of a bud arising from below. Wellington. ×2.

Fig. 3. The upper left-hand corner of Fig. 1. ×3.

Fig. 4. The lower left-hand corner of Fig. 1. ×3.

Fig. 5. A portion of the septal edge of Fig. 2. ×3.

Drawn from nature by Mr. P. T. Hammond.

1

3

5

4

2

P. T. Hainmond, del.

Heliotype

Department of Mines and Agriculture,
Geological Branch,

Sydney, 31. 10. 1895.

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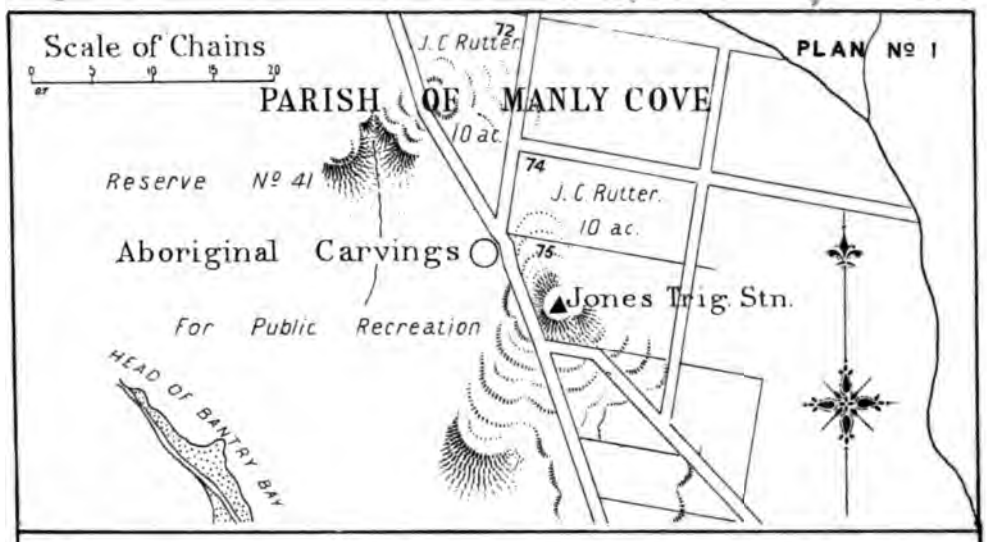
PLATE XXIII.

Sketch Plan, showing position of Aboriginal Rock Carvings, Parish of Manly Cove, County of Cumberland.

Scale—Plan No. 1, 10 chains to 1 inch.

Plan No. 2, 1 mile to 1 inch.



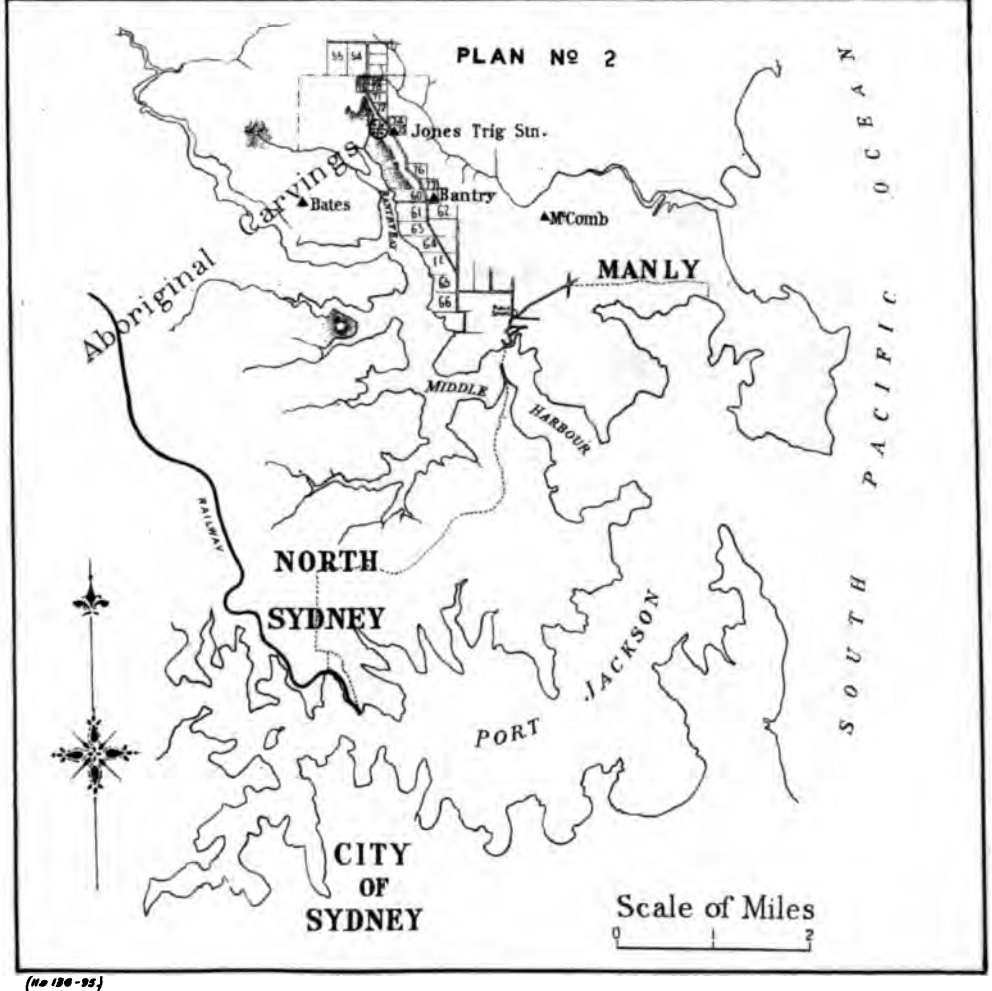


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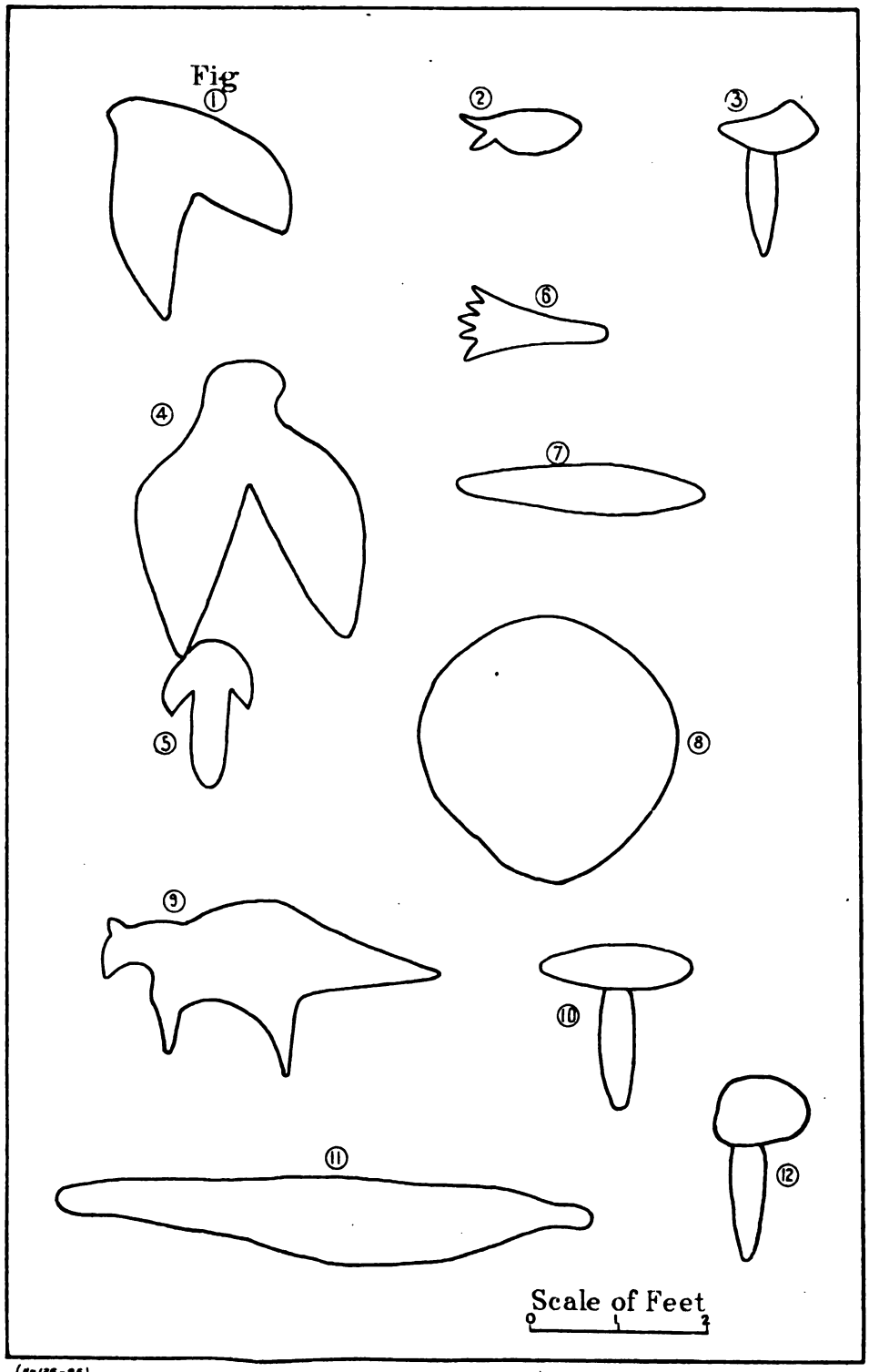
PLATE XXIV.

Aboriginal Rock Carvings at the head of Bantry Bay, Parish of Manly Cove, County of Cumberland.

Drawn by Mr. O. Trickett, from sketches and measurements.

Scale—1 inch to 1 foot.



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APRIL, 1894.

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MINING DISTRICTS.

or part of.	Mining District.	Gold-field.
shire (part of)	Tumut and Adelong	Umaralla.
(part of)	do do	Adelong Creek.
do	Peel and Uralla	Swamp Oak and Nundle.
	Mudgee	
	Albert	Albert.
	do	do
	Tumut and Adelong	Black Range (partly).
	Albert	Albert.
	do	do
	Peel and Uralla	Tingha.
	New England	Emmaville (partly).
	Bathurst	
	New England	Bourook and Lunatic.
	Bathurst	Caloola Creek (partly).
	New England	Emmaville (partly).
	Peel and Uralla	Tingha.
	Hunter and Macleay	
	Albert	Albert.
	Clarence and Richmond	Orara.
	Peel and Uralla	
(part of)	Tumut and Adelong	Molonglo (partly).
	New England	
	Clarence and Richmond	Tweed and Richmond Rivers (partly).
	Tambaroora, and Turon, and Mudgee.	Turon River (partly).
	Peel and Uralla	Hingara (partly).
(part of)	do do	do do
	Bathurst	Oberon.
	New England	Bourook and Lunatic.
	Albert	Albert.
	New England	Emmaville.
	Bathurst	Bowree (partly).
	Southern	Bremolary.
	do	
	do	
	Hunter and Macleay	Barrington and Gloucester.
	Peel and Uralla	Bingara.
	do do	do
	New England	Emmaville.
	Bathurst	
	New England	Emmaville.
	Albert	Albert.
	Peel and Uralla	
(part of).	Tambaroora and Turon.	Macquarie River, Stony Creek, and Ironbarks
	do do	Wellington.
	Albert	Albert.
	Bathurst	Mulgunnia and Abercrombie.
	Albert	Albert.

Parish, or part of.	Mining District	Gold-field.
Bookookara (pt. of)	New England	Bourook and Lunatic.
Do do	do do	do do
Bodoomlayt	Hunter and Macleay	Gloucester.
Bonna	Orbar	Bogan.
Do East	do	do
Do West	do	do
Bonnor Boonoo (pt. of).	New England	Bourook and Lunatic.
Boorook	do do	do do
Borainl	Hunter and Macleay	Gloucester.
Bowman	New England	Emmaville.
Boyd	Peel and Uralla	
Brangalgan	Turnut and Adelong	Bourke, Cooper, Dowling, and Gipps.
Branxton	Hunter and Macleay	
Bray	Albert	Albert.
Bringelliet (part of)	Bathurst	Caloola Creek.
Broadmeadows	Clarence and Richmond	Boyd or Little River.
Brooker (& Tomago)	Southern	Mogo (partly).
Brundah	Lachlan	Tyagong Creek.
Buangla (part of)	Southern	Yalwal.
Bullingong do	Turnut and Adelong	Molonglo (partly).
Bumbaldry	Lachlan	Tyagong Creek.
Bumbar	New England	Emmaville (partly).
Bundawarrah	Lachlan	Tenoes (partly).
Do (part of)	do	do do
Burbie	Southern	
Burra	Orbar	Bogan.
Burrandong	Tambaroora and Turon	Macquarie River, Stony Creek, Ironbarks, and Wellington.
Do (part of)	do do	Macquarie River, Stony Creek, and Ironbarks.
Burrill	Lachlan	Bogan.
Byjerkerno	Albert	Albert.
Byng	Bathurst	Byng (partly).
Byngrano	Albert	Albert.
Cadgee	Southern	Gulph (partly).
Calalal	Turnut and Adelong	Adelong Creek.
Callanyn (part of)	New England	Bourook and Lunatic.
Caloola (part of)	Albert	Albert.
Canowindra	Bathurst	Canowindra (partly).
Carroll (part of)	Tambaroora and Turon	Wellington.
Cargo	Lachlan	Cargo and Canowindra.
Do (part of)	do	Cargo.
Castlereagh	Bathurst	Turon River and Kirkconnell.
Cataract (part of)	New England	Bourook and Lunatic (partly).
Catscart	Albert	Albert.
Cavendish	New England	Timbarra and Bourook and Lunatic.
Cawarak	Hunter and Macleay	

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Parish, or part of.	Mining District.	Gold-field.
Abercrombie (part of)	Tumut and Adelong ..	Limeralls.
Adelong (part of) ..	do do ..	Adelong Creek.
Adelong do ..	Peel and Uralla.....	Swamp Oak and Mungale.
Airly.....	Mudgee	
Albert	Albert.....	Albert.
Alberta	do	do
Albury	Tumut and Adelong ..	Black Range (partly).
Alma	Albert	Albert.
Do (town of)....	do	do
Anderson	Peel and Uralla.....	Tingha.
Annandale	New England	Emmaville (partly).
Apsley (part of)	Bathurst	
Antimony	New England	Bocrook and Lunatic.
Arkell (part of)	Bathurst	Caloola Creek (partly).
Arvid	New England.....	Emmaville (partly).
Aston	Peel and Uralla.....	Tingha.
Awaba	Hunter and Macleay ..	
Ballerigaro	Albert	Albert.
Bagawa	Clarence and Richmond	Orara.
Bald Nobs.....	Peel and Uralla.....	
Ballalaba (part of)	Tumut and Adelong ..	Molonglo (partly).
Ballandean	New England.....	
Baliina	Clarence and Richmond	Tweed and Richmond Rivers (partly).
Bambawarra	Tambaroora, and Turon, and Mudgee.	Turon River (partly).
Bandemere	Peel and Uralla.....	Bingara (partly).
Do (part of)..	do do	do do
Baring	Bathurst	Oberon.
Barnet Brook....	New England.....	Boorook and Lunatic.
Barrangaga (part of)	Albert	Albert.
Barra (part of).....	New England.....	Emmaville.
Barrata	Bathurst	Barrata (partly).
Barrington	Southern.....	Dromedary.
Barrington	do	
Barrona	do	
Barrowarra.....	Hunter and Macleay ..	Barrington and Gloucester.
Bastors.....	Peel and Uralla.....	Bingara.
Bingara	do do	do
Do (part of) ..	New England.....	Emmaville.
Bingbi	Bathurst	
Binnalong	New England	Emmaville.
Binni	Albert	Albert.
Birch	Peel and Uralla.....	
Birrahlora (part of).	Tambaroora and Turon.	Macquarie River, Stony Creek, and Ironbarks
Boga (part of)	do do ...	Wellington.
Boora	Albert	Albert.
Bowman	Bathurst	Mulgunnia and Abercrombie.
Bowgadie	Albert	Albert.

Parish, or part of.	Mining District.	Gold-field.
Bookookam (pt. of)	New England.....	Boorook and Lunatic.
Do do ..	do do	do do
Bookoombayt	Hunter and Macleay ..	Gloucester.
Boona	Cobar	Bogan.
Do East.....	do	do
Do West.....	do	do
Boonoo Boonoo (pt. of).	New England.....	Boorook and Lunatic.
Boorook	do do	do do
Bonnal	Hunter and Macleay ..	Gloucester.
Bowman	New England.....	Emmaville.
Boyd	Peel and Uralla.....	
Brangalgan	Tumut and Adelong ..	Bourke, Cooper, Dowling, an Gipps.
Brannton	Hunter and Macleay ..	
Bray	Albert	Albert.
Bringelly (part of).	Bathurst	Caloola Creek.
Broadmeadows	Clarence and Richmond	Boyd or Little River.
Brodies (& Tomago)	Southern.....	Moga (partly).
Bromleigh	Lachlan	Tyagong Creek.
Bunagia (part of) ..	Southern.....	Yalwal.
Bullenglong do	Tumut and Adelong ..	Molonglo (partly).
Bumbaldry	Lachlan	Tyagong Creek.
Bundar	New England.....	Emmaville (partly).
Bundaweerah	Lachlan	Tenterfield (partly).
Do (part of)	do	do do
Burra	Southern.....	Bogan.
Burra	Cobar	Bogan.
Burrendong	Tambaroora and Turon.	Macquarie River, Stony Creek Ironbarks, and Wellington
Do (part of)	do do ..	Macquarie River, Stony Creek and Ironbarks.
Burrill	Lachlan	Bogan.
Byjerkerno	Albert	Albert.
Byng	Bathurst	Byng (partly).
Bungunno	Albert	Albert.
Calgar	Southern.....	Gulph (partly).
Calulat	Tumut and Adelong ..	Adelong Creek.
Callanyn (part of) ..	New England.....	Boorook and Lunatic.
Caloola (part of)....	Albert	Albert.
Canowindra	Bathurst	Canowindra (partly).
Carroll (part of)	Tambaroora and Turon	Wellington.
Cargo	Lachlan	Cargo and Canowindra.
Do (part of)	do	Cargo.
Castlereagh	Bathurst	Turon River and Richmond
Cataract (part of) ..	New England	Boorook and Lunatic (partly
Cathcart	Albert	Albert.
Cavendish	New England	Timbarra and Boorook an Lunatic.
Cassrook	Hunter and Macleay ..	

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ish, or part of.	Mining District.	Gold-field.	Parish, or part of.	Mining District.	Gold-field.
...mble (part of)	Tumut and Adelong	Umuralla.	Bookookara (pt. of)	New England	Beerook and Limatic.
...ong (part of)	do do	Adelong Creek.	Do do	do do	do do
...do	Peel and Uralla	Swamp Oak and Niangala.	Bookoolayt	Hunter and Macleay	Gloucester.
...	Mudgee		Boora	Cobar	Bogan.
...	Albert	Albert.	Do East	do	do
...	do	do	Do West	do	do
...	Tumut and Adelong	Black Range (partly).	Boraro Boooro (pt. of).	New England	Beerook and Limatic.
... (town of)	Albert	Albert.	Borrook	do do	do do
...	do	do	Borsael	Hunter and Macleay	Gloucester.
...	Peel and Uralla	Tingha.	Bowman	New England	Emmaville.
...	New England	Emmaville (partly).	Boyd	Peel and Uralla	
... (part of)	Bathurst		Brangalgan	Tumut and Adelong	Burrike, Cooper, Dunlop, and Gipps.
...	New England	Beerook and Limatic.	Brannon	Hunter and Macleay	Albert.
...	Bathurst	Cabonla Creek (partly).	Bray	Albert	Cabonla Creek.
...	New England	Emmaville (partly).	Bringallet (part of)	Bathurst	Boyd or Little River.
...	Peel and Uralla	Tingha.	Broadmeadows	Clarence and Richmond	Bingo (partly).
...	Hunter and Macleay		Bromley (& Towagn)	Southern	Tyagong Creek.
...	Albert	Albert.	Brunslab	Lachlan	Yalwal.
...	Clarence and Richmond	Orara.	Brungle (part of)	Southern	Molonglo (partly).
...	Peel and Uralla		Bullongong do	Tumut and Adelong	Tyagong Creek.
...	Tumut and Adelong	Molonglo (partly).	Bumbaldry	Lachlan	Emmaville (partly).
...	New England		Bundar	New England	Tenterfield (partly).
...	Clarence and Richmond	Tweed and Richmond Rivers (partly).	Bundaweerah	Lachlan	Tenterfield (partly).
...	Tambaroora, and Turon. and Mudgee.	Turon River (partly).	Do (part of)	do	do do
...	Peel and Uralla	Bingara (partly).	Burke	Southern	
... (part of)	do do	do do	Burra	Cobar	Bogan.
...	Bathurst	Oberon.	Burrendong	Tambaroora and Turon.	Macquarie River, Stony Creek, Ironbarks, and Wellington.
... (part of)	New England	Beerook and Limatic.	Do (part of)	do do	Macquarie River, Stony Creek, and Ironbarks.
...	Albert	Albert.	Burvill	Lachlan	Bogan.
...	New England	Emmaville.	Byjerkerro	Albert	Albert.
...	Bathurst	Emmaville (partly).	Byng	Bathurst	Byng (partly).
...	Southern	Bronco (partly).	Byngrano	Albert	Albert.
...	do	Drumedary.	Cadgar	Southern	Gulph (partly).
...	Hunter and Macleay		Calalat	Tumut and Adelong	Adelong Creek.
...	Peel and Uralla	Barrington and Gloucester.	Callanyn (part of)	New England	Beerook and Limatic.
...	do do	Bingara.	Calonla (part of)	Albert	Albert.
... (part of)	New England	do	Canowindra	Bathurst	Canowindra (partly).
...	Bathurst	Emmaville.	Carroll (part of)	Tambaroora and Turon.	Wellington.
...	New England		Cargo	Lachlan	Cargo and Canowindra.
...	Albert	Emmaville.	Do (part of)	do	Cargo.
...	Peel and Uralla	Albert.	Castlerea	Bathurst	Turon River and Kirkconnell.
... (part of)	Tambaroora and Turon.		Catarach (part of)	New England	Beerook and Limatic (partly).
... (part of)	do do	Macquarie River, Stony Creek, and Ironbarks	Cathcart	Albert	Albert.
...	Albert	Wellington.	Carnelish	New England	Timbarra and Beerook and Limatic.
...	Bathurst	Albert.	Cannock	Hunter and Macleay	
...	Albert	Molgounla and Abereramble.			
		Albert.			

MINING DISTRICTS—*continued.*

Parish, or part of.	Mining District.	Gold-field.
Chalmers (part of)	Peel and Uralla	Upper Hunter (partly).
Churchill do	New England	Sutherland.
Clare	Peel and Uralla	Tingha.
Clarence (part of)	New England	Tenterfield Creek.
Clifford do	Tumut and Adelong	Unnamed.
Clinton	Bathurst	Ophir.
Clive	Peel and Uralla	Tingha.
Coeli (part of)	Albert	Albert.
Colar	Colar	Bogan.
Cole (part of)	Bathurst	Vowchelga (partly).
Collett	Lachlan	Canowindra.
Colquhoun	New England	Hillgrove Creek and Lunatic.
Comlaroi	Clarence and Richmond	Orara.
Cooma	Bathurst	
Cookamidgera	Tumbarumba and Tumut	Macquarie River, Stoney Creek, and Ironbarks.
Cookamidgal	Bathurst	Turon River.
Coonamalla	Albert	Albert.
Cooney	Peel and Uralla	Gyra River.
Do (part of)	do do	do
Coolumbong	Hunter and Macleay	
Cope's Creek	Peel and Uralla	Tingha.
Corella	Colar	Bogan.
Cookmus	Southern	
Corona	Albert	Albert.
Corry (part of)	New England	Hillgrove Creek and Lunatic.
Cowanly	Peel and Uralla	Kookabookra.
Cox	Bathurst	
Cranbrook (part of)	New England	Emmaville.
Cravon	Hunter and Macleay	Gloucester.
Cullen Bullen	Bathurst	Turon River (partly).
Cunnawarra	New England	
Cunningar (part of)	Tumbarumba and Tumut	Wallington.
Curragurra do	do do	Macquarie River, Stony Creek and Ironbarks.
Currabung do	Lachlan	Billabong.
Currambene	Southern	Cochrougatta (partly).
Currowki	Hunter and Macleay	Gloucester.
Dalhousie (part of)	Clarence and Richmond	Boyd or Little River.
Dalserf do	Southern	Yalwal.
Darlot	Peel and Uralla	Tingha.
Dava Dava	do do	Dungara (partly).
Do (part of)	do do	do do
Daving	Albert	Albert.
Dixon	do	do
Digby	Peel and Uralla	
Dungo	do do	Bingara.
Do (part of)	do do	do
Dumaresq	New England	Emmaville.
Dangarsleigh	Peel and Uralla	Peel River.
Dunlop (part of)	Bathurst	Millburn Creek.
Eglinton	Albert	Albert.
Ellerslie	Colar	Bogan.
Elsmore	Peel and Uralla	Tingha (partly).
Emmett	Albert	Albert.
Do	Peel and Uralla	Gyra River Extension.
Enfield	Bathurst	Clear Creek and Kirkconnell (partly).
Ettrema	Southern	Yalwal.
Evelyn (part of)	Tumut and Adelong	Adelong Creek (partly).
Exmoor	Peel and Uralla	Ironbarks and Tenterfield.
Ewenfield	Bathurst	Kirkconnell and Mount Tamble (partly).
Fairy Hill	Albert	Albert.
Falnash	Bathurst	Turon River (partly).
Fitzroy	Colar	Bogan.
Flagstone	New England	Emmaville.
Forbes	Lachlan	Billabong and Lachlan, Wellington, Macquarie River.
Do (part of)	Bathurst	Stony Creek, Ironbarks, and Ophir.
Fowler's Gap do	Albert	Albert.
Frascatello do	Bathurst	Ophir (partly).
Fraser	New England	Emmaville.
Do	do	
Galara (part of)	Tumut and Adelong	Adelong Creek (partly).
Gardner's Creek	Albert	Albert.
Galbraith	Bathurst	Newtonridge and Calmela Creek (partly).
Do (part of)	do	Newtonridge (partly).
Glenlyar do	New England	

Parish, or part of.	Mining District.	Gold-field.
Glen (part of)	Albert	Albert.
Gologuy do	New England	Tenterfield and Lunatic.
Gilmandyke	Colar	Bogan.
Gilliadeh	Bathurst	Junction Point, Turon Creek and Mariedale.
Glenlion	Tumut and Adelong	Orange Creek.
Gnoupa	Southern	Pambula.
Gontoongdek	Hunter and Macleay	Gloucester.
Gordon	Peel and Uralla	
Goanna (part of)	do do	Bingara.
Greene	Hunter and Macleay	Newcastle and Gloucester.
Gulgong	Mudgee	Gulgong.
Gulph (part of)	Southern	Gulph (partly).
Gundowring	Mudgee	Gulgong.
Hall	Peel and Uralla	Kookabookra.
Do	do	Ironbark and Tenterfield.
Do	do	Bingara (partly).
Do (part of)	do	do
Hamilton	New England	Emmaville (partly).
Hampton	Bathurst	Belubula do
Hanning	Peel and Uralla	
Hargraves	Mudgee	Wallington.
Hartley	Bathurst	
Haystack	New England	Emmaville.
Heathcote	Southern	
Herbert	Peel and Uralla	Tingha.
Herlson	Hunter and Macleay	Orara.
Highland Home	New England	Emmaville.
Hughes	Albert	Albert.
Ironbarks (part of)	Tumbarumba and Tumut	Macquarie River, Stony Creek, Ironbarks, and Muckerora.
Jamberoo	Southern	Nerrimunga.
Jerrawill	Peel and Uralla	
Jamberoo	Southern	
Jamieson	Bathurst	
Jallaru	Southern	
Jarrahdenera	do	Shoalhaven and Shoalhaven River (partly).
Jingellic East	Tumut and Adelong	Dunnat Creek.
Jindja	Southern	
Jocelyn	Bathurst	Glenlyon
Kahibah	Hunter and Macleay	
Kangaloon	Southern	
Kelloola	Bathurst	
Kentish	Southern	
Kirk	Albert	Albert.
Lake Macquarie	Hunter and Macleay	
Land's End	New England	Emmaville.
Langdale (part of)	Bathurst	Glenlyon (partly).
do	do	Ophir do
Lawson	Albert	Albert.
Lewis	Bathurst	Ophir (partly).
Do (part of)	do	Mount Tamble (partly).
Liddesdale	Peel and Uralla	Swamp Oak and Nowgala (partly).
Loftus (part of)	do do	Bingara (partly).
Macintyre (part of)	Albert	Albert.
Maharatta	Lachlan	Barrandonian (partly).
Mandamah (part of)	Hunter and Macleay	
Maitland	Lachlan	Belubula
Manildra	Bathurst	
Marangaroo	do	Ophir
Marsh (part of)	New England	
Marsh	Lachlan	Billabong.
Martin	Southern	Argyle, Camden, and King.
Marulan	New England	
Maryland	Peel and Uralla	Tingha.
Mayo	Bathurst	
Megalong	Peel and Uralla	Gyra River.
Merrigalah (part of)	do do	do
Mata	do do	do
Do (part of)	Colar	Bogan.
Micanalli	Albert	Albert.
Milroy (part of)	Mudgee	Tambaroora.
Mongolo do	Peel and Uralla	
Mitchell	do do	Kookabookra and Ovaro.
Do (part of)	do do	Bingara.
Molroy	Southern	Macquarie River (partly).
Mongarlowe	Peel and Uralla	Upper Hunter.
Morman (part of)	Albert	Albert.
Moorlands	Colar	Bogan.
Mopallamba		

MINING DISTRICTS—*continued.*

Parish, or part of.	Mining District.	Gold-field.
Murrua	Southern	Monkya (partly).
Mowabong	Molyne	
Monia	Bathurst	
Mount Allen	Colar	Bogan.
Mount Gipps	Albert	Albert.
Mount Hope	Colar	Bogan.
Muckerwa (part of)	Tambaroora and Turon	Macquarie River, Stony Creek, Louisiana, and Muckerwa.
Do do	do do	do do
Mugincble	Lachlan	Billabong.
Muir	New England	Emmaville.
Mulgunnia	Bathurst	Mangunnia and Abercrombie (partly).
Mundi Mundi	Albert	Albert.
Munnabarina	Tumut and Adelong	Black Range (partly).
Murga	Colar	Bogan.
Myall	Peel and Uralla	Tingara.
Nadhurst	Albert	Albert.
Narabri	do	do
Narrangarril	Southern	Argyle, Camden, and King.
Nepean	Bathurst	
Nerrigundah (part of)	Southern	Gulph (partly).
Nerrimunga	do	Nerrimunga Creek.
New England Mining District.		
Newry	Peel and Uralla	Ironbark and Tea-tree (partly).
Do	Hunter and Macleay	Orara.
Nemcoona	Southern	Deniliquin.
Do (part of)	do	do
Nimmitabla do	Albert	Albert.
Nimbin	Clarence and Richmond	Boyd or Little River (partly).
Nimmo (part of)	Peel and Uralla	Peel River (partly).
Nullum	Clarence and Richmond	Tweed and Richmond Rivers.
Oallen (part of)	Southern	Shoalhaven and Shoalhaven River.
Oberon	Bathurst	Oberon.
Odonnell (part of)	Peel and Uralla	Upper Hunter.
Ogilvie	Hunter and Macleay	
Omadale	Peel and Uralla	Upper Hunter.
Opbirs	Albert	Albert.
Opora	Southern	Argyle, Camden, and King.
Orr (part of), Mount Brown.	Albert	Albert.
Pampare	do	do
Para	do	do
Paradise North	New England	Emmaville.
Parkes	Lachlan	Billabong.
Pilcon	Albert	Albert.
Pressato (part of)	Peel and Uralla	Upper Hunter.
Pumamoota	Albert	Albert.
Purvis (part of)	New England	Emmaville.
Reid do	do do	Bostock and Lunatic.
Rilee	Albert	Albert.
Rock Glen	New England	Emmaville.
Rockvale	do do	do
Rumley (part of)	do do	do
Rose Valley do	Tumut and Adelong	Umaralla.
Ruby	New England	Bostock and Lunatic (partly).
Rusden	Peel and Uralla	
Ryes (part of)	do do	Rockaroobooka.
Do do	do do	do
Sandfield	Colar	Bogan.
Scone	Peel and Uralla and New England	Dartmouth (partly).
Seaka	Peel and Uralla	
Sebastopol	Tumut and Adelong	Sebastopol, Junee, and Urangilly (partly).
Do	Albert	Albert.
Seeley (part of)	Peel and Uralla	Rockaroobooka.
Seaforth	Albert	Albert.
Severn (part of)	Peel and Uralla	
Silent Grove (pt. of)	New England	Emmaville (partly).
Sleaford	Peel and Uralla	Tingha do
Sobala	Tambaroora and Turon	Turon River.
Somers (part of)	Bathurst	Gully Swamp and Black Hills (partly).
Somerset	Colar	Bogan.
Sophia	Albert	Albert.
Southcot	Southern	
South Gundagai	Tumut and Adelong	Adelong Creek and Gundagai.

Parish, or part of.	Mining District.	Gold-field.
Springbrook	Clarence and Richmond	Boyd or Little River.
Stanford	Hunter and Macleay	
Stephen	Albert	Albert.
Stockington	Hunter and Macleay Extended.	
Stockton	Hunter and Macleay	
Do (part of)	do do	
Stonehenge	Peel and Uralla	
Stowell	Hunter and Macleay	
Strathee	New England	Emmaville (partly).
Strathfingle	do do and Peel and Uralla.	do do
Do North	New England	do do
Strathpey (part of)	do do	Bostock and Lunatic.
Sutton	Hunter and Macleay	
Swinton	Peel and Uralla	Tingha.
Tabragar	Molyne	Cudgegong.
Tallagunda (part of)	Southern	
Tambaroora do	Tambaroora and Turon	Wellington.
Para	Albert	Albert.
Tebrarose	Hunter and Macleay	Gloucester (partly).
Tenandra	Molyne	Mitchell's Creek.
Tent Hill	New England	Emmaville (partly).
Terallia	Hunter and Macleay	
Thornleigh	Bathurst	Mount Lambie.
Tiengs	Peel and Uralla	
Timbarra	New England	Bostock and Lunatic, and Timbarra.
Tuango	Southern	Mogo (partly).
Tuncare	Hunter and Macleay	
Tuning	Lachlan	Canyonleigh and Canyonleigh (partly).
Tupa Tupa	Hunter and Macleay	Gloucester.
Turrawangee	Albert	Albert.
Turuna (part of)	Bathurst	King's Plains.
Tyat	Colar	Bogan.
Tyrahill (part of)	Tambaroora and Turon	Wellington.
Tyrgalong	Lachlan	Tenora.
Tuma	Bathurst	Abercrombie.
Tuggerah	Hunter and Macleay	
Tumberumba	Tumut and Adelong	Tumberumba, Gurance, and Burra Creek (partly).
Undercliff (part of)	New England	Bostock and Lunatic.
Unicot do	Tumut and Adelong	
Umberumberka	Albert	Albert.
Umarrah (part of)	Tambaroora and Turon	Wellington.
Urabolalla do	Southern	
Wahba	Peel and Uralla	Swamp Oak and Nimrods.
Wallah Wallah	Lachlan	Lachlan.
Wallawalla	do	Gundahindyal.
Walters (part of)	Tambaroora and Turon	Wellington.
Wargal	Hunter and Macleay	Gloucester.
Warragamba	Bathurst	
Warrator (part of)	Molyne	Wellington.
Warro Warral	Tumut and Adelong	Sebastopol, Junee, and Urangilly.
Wankarei	Albert	Albert.
Wellington North	New England	Emmaville (partly).
Wellington Vale	do do	do do
Wells	Tambaroora and Turon	
Wertago	Albert	Albert.
West Fairfield	New England	Timbarra.
Willis Plains	Tumut and Adelong	Adelong Creek.
Wilyama, (village of)	Albert	Albert.
Winsor (part of)	Molyne	Wellington.
Wooroa	Southern	
Wongwilli	do	
Wood's Reef	Peel and Uralla	Iron-bark and Tea-tree.
Worara	Albert	Albert.
Worcester	Bathurst	Ophir.
Worra	Peel and Uralla	Kookaroobooka.
Wrahba	Molyne	Gulgong.
Wrankarra	Southern	
Wylie	New England	Bostock and Lunatic (partly).
Yalwal (part of)	Southern	Yalwal.
Yarrawalma	Albert	Albert.
Do North	do	do
Yarralaa	Southern	Argyle, Camden, and King.
Yeomp (part of)	Lachlan	Burrangong.
Yewaka	Southern	Parishes.
Do (part of)	do	do

CATALOGUE OF MINING MAPS

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MINING DISTRICTS.

r part of.	Mining District.	Gold-field	Parish, or part of.	Mining District.	Gold-field.
...e (part of)	Tumut and Adelong	Umaralla.	Bookookara (pt. of)	New England	Bostock and Lunatic.
part of)	do do	Adelong Creek.	do do	do	do do
do	Peel and Uralla	Swamp Oak and Niangala.	Bolobombat	Hunter and Macleay	Gloucester.
	Mudgee		Burma	Cobar	Bogan.
	Albert	Albert.	Do East	do	do
	do	do	Do West	do	do
	Tumut and Adelong	Black Range (partly).	Bowan Downs (pt. of).	New England	Bostock and Lunatic.
...en of)	Albert	Albert.		do do	do do
	do	do	Boorook	Hunter and Macleay	Gloucester.
	Peel and Uralla	Tingha.	Bonanel	New England	Emmaville.
	New England	Emmaville (partly).	Bowman	Peel and Uralla	
	Bathurst		Boyd	Tumut and Adelong	Bombo, Cooper, Bowlia Gipps.
	New England	Bostock and Lunatic.	Bowanga		
...t of)	Bathurst	Caloola Creek (partly).	Bourdon	Hunter and Macleay	
	New England	Emmaville (partly)	Bray	Albert	Albert.
	Peel and Uralla	Tingha.	Bringelly (part of)	Bathurst	Caloola Creek.
	Hunter and Macleay		Broadmeadows	Clarence and Richmond	Bord ra Little River.
	Albert	Albert.	Brooks (& Tuross)	Southern	Mogo (partly).
	Carrington and Richmond	Orara	Brundah	Lachlan	Tyagong Creek.
	Peel and Uralla		Bungalo (part of)	Southern	Yalwal.
(part of)	Tumut and Adelong	Molonglo (partly).	Bullenging do	Tumut and Adelong	Molonglo (partly).
	New England		Bumbaldry	Lachlan	Tyagong Creek.
	Clarence and Richmond	Tweed and Richmond Rivers (partly).	Bundar	New England	Emmaville (partly).
	Tambaroora, and Turon, and Mudgee.	Turon River (partly).	Bundawarrah	Lachlan	Tuross (partly).
	Peel and Uralla	Bingara (partly).	Do (part of)	do	do do
(part of)	do do	do do	Burke	Southern	
	Bathurst	Oberon.	Burra	Cobar	Bogan.
	New England	Bostock and Lunatic.	Burrandong	Tambaroora and Turon	Macquarie River, Sloop's Ironbarks, and Wellin
	Albert	Albert.	Do (part of)	do do	Macquarie River, Sloop's and Ironbarks.
	New England	Emmaville		Lachlan	Bogan.
	Bathurst	Bencrec (partly)	Burrill	Albert	Albert.
	Southern	Dromedary.	Byjarkerno	Bathurst	Byng (partly).
	do		Byng	Albert	Albert.
	do		Bengrano	southern	Gulph (partly).
	Hunter and Macleay	Barrington and Gloucester.	Cadgee	Tumut and Adelong	Adelong Creek.
	Peel and Uralla	Bingara.	Calabar	New England	Bostock and Lunatic.
	do do	do	Calarayt (part of)	Albert	Albert.
	New England	Emmaville.	Caloola (part of)	Bathurst	Canowindra (partly).
	Bathurst		Canowindra	Tambaroora and Turon	Wellington.
	New England	Emmaville.	Carroll (part of)	Lachlan	Cargo and Canowindra.
	Albert	Albert.	Cargo	do	Cargo.
	Peel and Uralla		Do (part of)	Bathurst	Turon River and Birkon
	Tambaroora and Turon	Macquarie River, Stony Creek, and Ironbarks	Castleton	New England	Bostock and Lunatic (pa
	do do	Wellington.	Cataract (part of)	Albert	Albert.
	Albert	Albert.	Catherari	New England	Tambaroa and Bostock Lunatic.
	Bathurst	Mulgowaia and Abercrombie.	Cavendish		
	Albert	Albert.	Cassock	Hunter and Macleay	

MINING DISTRICTS—*continued.*

Parish, or part of.	Mining District.	Gold-field.
Chalmers (part of)	Peel and Uralla	Upper Hunter (partly).
Churchill do	New England	Sofferino.
Clare	Peel and Uralla	Tingha.
Clarence (part of)	New England	Tralleen Creek.
Clifford do	Tumut and Adelong	Gwavilla.
Clinton	Bathurst	Ophir
Clive	Peel and Uralla	Tingha.
Coelly (part of)	Albert	Albert.
Colar	Colar	Bogan.
Cole (part of)	Bathurst	Newbridge (partly).
Collett	Lachlan	Castlereagh.
Colnaise	New England	Inverell and Limatic.
Condobolin	Clarence and Richmond	Orara.
Cooke	Bathurst	
Cookamidgera	Tantawanglo and Tumut	Macquarie River, Hume Creek, and Ironbarks.
Cookamidgera	Bathurst	Turon River.
Coolamatta	Albert	Albert.
Cooper	Peel and Uralla	Cyra River.
Do (part of)	do do	do
Corowbung	Hunter and Macleay	
Cowal Creek	Peel and Uralla	Tingha.
Cowlis	Colar	Bogan.
Cowlumla	Southern	
Cowra	Albert	Albert.
Cox's (part of)	New England	Inverell and Limatic.
Cowsley	Peel and Uralla	Ironbarks.
Coz	Bathurst	
Cranbrook (part of)	New England	Emmaville.
Craven	Hunter and Macleay	Gloucester.
Cudgen Creek	Bathurst	Tyrra River (partly).
Cullendore	New England	
Cunningar (part of)	Tantawanglo and Tumut	Wellington.
Currawarna do	do do	Macquarie River, Stony Creek and Ironbarks.
Curranulla	Lachlan	Billabong.
Currantlaw	Southern	Cucumgenta (partly).
Currock	Hunter and Macleay	Gloucester.
Dalmorton (part of)	Clarence and Richmond	Bird or Little River.
Darlgera do	Southern	Yalwal.
Darby	Peel and Uralla	Tingha.
Dgra Dgra	do do	Bingara (partly).
Do (part of)	do do	do do
Daring	Albert	Albert.
Dawes	do	do
Digby	Peel and Uralla	
Dingo	do do	Bingara.
Do (part of)	do do	do
Donnybrook	New England	Emmaville.
Doongowan	Peel and Uralla	Peel River.
Dunbury (part of)	Bathurst	Millburn Creek.
Edgar	Albert	Albert.
Elbesilla	Colar	Bogan.
Elsmere	Peel and Uralla	Tingha (partly).
Enmore	Albert	Albert.
Do	Peel and Uralla	Gyra River Extension.
Enfield	Bathurst	Clear Creek and Kirkconnell (partly).
Erina	Southern	Yalwal.
Esdera (part of)	Tumut and Adelong	Adelong Creek (partly).
Esmur	Peel and Uralla	Ironbarks and Tea-tree.
Esdale	Bathurst	Kirkconnell and Mount Lambie (partly).
Fairy Hill	Albert	Albert.
Falmash	Bathurst	Turon River (partly).
Fitzroy	Colar	Bogan.
Flagstone	New England	Emmaville.
Forbes	Lachlan	Billabong and Lachlan, Wellington, Macquarie River.
Do (part of)	Bathurst	Stony Creek, Ironbarks, and Ophir.
Foster's Gap do	Albert	Albert.
Fremantle do	Bathurst	Ophir (partly).
Fraser	New England	Emmaville.
Do	do	
Gadara (part of)	Tumut and Adelong	Adelong Creek (partly).
Gairdner's Creek	Albert	Albert.
Galbraith	Bathurst	Newbridge and Cabbala Creek (partly).
Do (part of)	do	Newbridge (partly).
Gibraltar do	New England	

Parish, or part of.	Mining District.	Gold-field.
Giles (part of)	Albert	Albert.
Gilgurry do	New England	Beardy and Limatic.
Gilfeibine	Colar	Bogan.
Gilliulish	Bathurst	Junction Point, Tuena Creek and Markdale.
Gimlan	Tumut and Adelong	Gundagai Creek.
Gipsup	Southern	Peelwalk.
Gobbagumbalin	Hunter and Macleay	Gloucester.
Gordon	Peel and Uralla	
Gouron (part of)	do do	Bingara.
Greene	Hunter and Macleay	Nowendoc and Gloucester.
Gulgong	Mudgee	Gulgong.
Gulph (part of)	Southern	Gulph (partly).
Gundaseng	Mudgee	Gulgong.
Hall	Peel and Uralla	Nundle and Tea-tree.
Do	do	Ironbark and Tea-tree.
Ida	do	Bingara (partly).
Ida (part of)	do	do
Hamilton	New England	Emmaville (partly).
Hampden	Bathurst	Bathurst do
Hanning	Peel and Uralla	
Hargrave	Mudgee	Wellington.
Hartley	Bathurst	
Haystack	New England	Emmaville.
Heathcote	Southern	
Herbert	Peel and Uralla	Tingha.
Herbert	Hunter and Macleay	Orara.
Highland Home	New England	Emmaville.
Hughes	Albert	Albert.
Ironbarks (part of)	Tantawanglo and Tumut	Macquarie River, Stony Creek, Ironbarks, and Muckerawa.
Inverary	Southern	Nerrimunga.
Inverell	Peel and Uralla	
Jamberoo	Southern	
Jamieson	Bathurst	
Jellore	Southern	
Jerrabattgulla	do	Shoalhaven and Bendeleo River (partly).
Jingellic East	Tumut and Adelong	Gundagai Creek.
Joadja	Southern	
Jocelyn	Bathurst	Ophir.
Kalibah	Hunter and Macleay	
Kanaraloon	Southern	
Kelloola	Bathurst	
Kembla	Southern	
Kirk	Albert	Albert.
Lake Macquarie	Hunter and Macleay	
Land's End	New England	Emmaville.
Langdale (part of)	Bathurst	Ophir (partly).
Lennox	do	Ophir do
Lewis	Albert	Albert.
Do (part of)	Bathurst	Ophir (partly).
Lidsdale	do	Mount Lambie (partly).
Loftus (part of)	Peel and Uralla	Swamp Oak and Nundle (partly).
Macintyre (part of)	do do	Bingara (partly).
Maharatta	Albert	Albert.
Mandamah (part of)	Lachlan	Barmedman (partly).
Mandelong	Hunter and Macleay	
Manildra	Lachlan	Lligo
Manuagaro	Bathurst	
March (part of)	do	Ophir.
Marsh	New England	
Martin	Lachlan	Billabong.
Maruhan	Southern	Argyle, Canalon, and Kingsdale.
Maryland	New England	
Mayo	Peel and Uralla	Tingha.
Megalong	Bathurst	
Merrendah (part of)	Peel and Uralla	Gyra River.
Metz	do do	do
Do (part of)	do do	do
Mickmill	Colar	Bogan.
Milling (part of)	Albert	Albert.
Mingelo do	Mudgee	Tomingley.
Mitchell	Peel and Uralla	
Do (part of)	do do	Kookaburnum and Orara.
Molroy	do do	Bingara.
Mongarlowe	Southern	Mongarlowe River (partly).
Moonan (part of)	Peel and Uralla	Upper Hunter.
Moorlels	Albert	Albert.
Moquillamba	Colar	Bogan.

MINING DISTRICTS—*continued.*

Parish, or part of.	Mining District.	Gold-field.
[illegible]	Southern	Mooney (partly).
[illegible]	Mudgee	
[illegible]	Bathurst	
Mount Allen	Cobar	Began.
Mount Dipps	Albert	Albert.
Mount Hope	Cobar	Began.
Muckerous (part of)	Tamharoora and Turon	Macquarie River, Stony Creek, Ironbarks, and Muckerous.
Do. do.	do do	do do
Myganmatic	Lachlan	Billabong.
Nail	New England	Emmaville
Nakroomla	Bathurst	Mulgoonia and Abercrombie (partly).
Nandi (Hund)	Albert	Albert.
Nangamarina	Tumut and Adelong	Black Range (partly).
Nanga	Cobar	Began.
Nardi	Peel and Uralla	Bingara.
Nelungaloo	Albert	Albert.
Nerallie	do	do
Nettlemarrie	Southern	Argyle, Camden, and King.
Nepean	Bathurst	
Nerrigundah (part of)	Southern	Gulph (partly).
Nerrimunga	do	Narrimunnah Creek.
New England Mining District.		
Newry	Peel and Uralla	Ironbark and Tenterfield (partly).
Do	Hunter and Macleay	Oxley.
Nicholson	Southern	Deniesbary.
Do. (part of)	do	do
Nimmobulla do	Albert	Albert.
Nobbinga	Clarence and Richmond	Boyd or Little River (partly).
Nundle (part of)	Peel and Uralla	Peel River (partly).
Nullum	Clarence and Richmond	Tweed and Richmond Rivers.
Nullum (part of)	Southern	Shoalhaven and Shoalhaven River.
Nurrie	Bathurst	Oberon.
Nundle (part of)	Peel and Uralla	Upper Hunter.
Nyee	Hunter and Macleay	
Nundle	Peel and Uralla	Upper Hunter.
Nyhan	Albert	Albert.
Nyton	Southern	Argyle, Camden, and King.
Oberon (part of), Mount Brown	Albert	Albert.
Obyan	do	do
Orara	do	do
Oraldra North	New England	Emmaville.
Orchan	Lachlan	Billabong.
Orana	Albert	Albert.
Orangery (part of)	Peel and Uralla	Upper Hunter.
Ormindale	Albert	Albert.
Orroral (part of)	New England	Emmaville.
Ord and do	do do	do do
Orlando	Albert	Albert.
Orlock Glen	New England	Emmaville.
Orlockvale	do do	do
Ormsby (part of)	do do	do
Ovens Valley do	Tumut and Adelong	Umaralla.
Oxley	New England	Severnock and Lunatic (partly).
Oxnton	Peel and Uralla	
Pace (part of)	do do	Emmaville.
Do do	do do	do
Packenbi	Cobar	Began.
Paine	Peel and Uralla and New England.	Emmaville (partly).
Paoti	Peel and Uralla	
Pambula (part of)	Tumut and Adelong	Sebastopol, Jimmy, and Umaralla (partly).
Do	Albert	Albert.
Parkes (part of)	Peel and Uralla	Kookaburnooka.
Parnell	Albert	Albert.
Parramatta (part of)	Peel and Uralla	
Parrong (part of)	New England	Emmaville (partly).
Parry	Albert	Albert.
Patrick Plains	Peel and Uralla	Tamharoora and Turon.
Peak (part of)	Bathurst	Gully Swamp and Black Hills (partly).
Peelwood	Cobar	Began.
Peisley	Albert	Albert.
Pejar	Southern	
Penrith Goodagong	Tumut and Adelong	Adelong Creek and Gundagai.

Parish, or part of.	Mining District.	Gold-field.
Springbrook	Clarence and Richmond	Boyd or Little River.
Stanford	Hunter and Macleay	
Stephen	Albert	Albert.
Stockington	Hunter and Macleay Extended.	
Stockton	Hunter and Macleay	
Do (town of)	do do	
Stonehenge	Peel and Uralla	
Stowell	Hunter and Macleay	
Strahan	New England	Emmaville (partly)
Strathbogie	do do and Peel and Uralla.	do do
Do North	New England	do do
Strathlepar (part of)	do do	Severnock and Lunatic
Suttor	Hunter and Macleay	
Swanton	Peel and Uralla	Tingha.
Tallawgalo	Mudgee	Gulgong.
Tallegandi (part of)	Southern	
Tamharoora do	Tamharoora and Turon	Wellington.
Tara	Albert	Albert.
Tebrastee	Hunter and Macleay	Gloucester (partly).
Tenandra	Mudgee	Meadow's Creek.
Tent Hill	New England	Emmaville (partly).
Teralba	Hunter and Macleay	
Thomasbrook	Bathurst	Mount Lambie.
Tienga	Peel and Uralla	Severnock and Lunatic and Timbarra.
Timbarra	New England	Hogs (partly).
Tomago	Southern	Abercrombie and Queanbeyan (partly).
Tomaree	Hunter and Macleay	Gloucester.
Tooloom	Lachlan	Albert.
Topi Topi	Hunter and Macleay	Rouse's Plains.
Torrowangee	Albert	Albert.
Torrens (part of)	Bathurst	Hogs.
Tout	Cobar	Began.
Trianbil (part of)	Tamharoora and Turon	Wellington.
Trigalong	Lachlan	Tenterfield.
Tuena	Bathurst	Abercrombie.
Tuggerah	Hunter and Macleay	
Tumbarumba	Tumut and Adelong	Tumbarumba, Omeo, and Burra Creek (partly).
Tuncurry	New England	Severnock and Lunatic.
Undercliff (part of)	Tumut and Adelong	Albert.
Undoo do	Albert	Albert.
Undermisterka	Tamharoora and Turon	Wellington.
Ungarah (part of)	Southern	
Unhomalla do	Peel and Uralla	Swamp Oak and Nineveh.
Walcha	Lachlan	Lachlan.
Wallah Wallah	do	Gundahaloy'si.
Wallandry	Tamharoora and Turon	Wellington.
Walora (part of)	Hunter and Macleay	Gloucester.
Wangat	Bathurst	
Warragamba	Mudgee	Wellington.
Warrabra (part of)	Tumut and Adelong	Belvedere, Jimmy, and Umaralla.
Warra Warral	Albert	Albert.
Waukaroo	New England	Emmaville (partly).
Wellington North	do do	do do
Wellington Vale	Tamharoora and Turon	Albert.
Wells	Albert	Albert.
Wertago	New England	Timbarra.
West Fairfield	Tumut and Adelong	Adelong Creek.
White Plains	Albert	Albert.
Williams, (village of)	Mudgee	Wellington.
Windeyer (part of)	Southern	
Woonona	do	
Woragwidi	Peel and Uralla	Ironbark and Tenterfield.
Wood's Reef	Albert	Albert.
Worara	Bathurst	Ophir.
Worcester	Peel and Uralla	Kookaburnooka.
Worra	Mudgee	Gulgong.
Wyaldra	Southern	
Wyuhome	New England	Severnock and Lunatic (partly).
Wylie	Tumut and Adelong	Yalwal.
Yalwal (part of)	Southern	Albert.
Yarrowitch	Albert	do
Do North	do	Argyle, Camden, and King.
Yarralaw	Southern	Burrangong.
Yeoval (part of)	Lachlan	Pambula.
Yowaka	Southern	do
Do (part of)	do	

CATALOGUE OF MINING MAPS

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MINING DISTRICTS.

...ds, or part of.	Mining District.	Gold-field.	Parish, or part of.	Mining District.	Gold-field.
...combe (part of)	Tumut and Adelong	Ulamalla.	Bankstown (pt. of)	New England	Bonnett and Lowell.
...ng (part of)	do do	Adelong Creek.	do do	do do	do do
...do	Peel and Uralla	Swamp Oak and Niangala.	Bankstown (pt. of)	Hunter and Macleay	Glenrock.
...	Bligh		Barrie	Cobar	Began.
...	Albert	Albert.	Do East	do	do
...	do	do	Do West	do	do
...	Tumut and Adelong	Black Range (part of).	Bannee Downs (pt. of).	New England	Bonnett and Lunatic.
...	Albert	Albert.	Berrenk	do do	do do
... (town of)	do	do	Bernard	Hunter and Macleay	Glenrock.
...	Peel and Uralla	Tingha.	Bowman	New England	Emmaville.
...	New England	Emmaville (partly).	Boyd	Peel and Uralla	
... (part of)	Bathurst		Bringalgan	Tumut and Adelong	Bowyer, Cooper, Dowling, and Gilgai.
...	New England	Bonnett and Lunatic.	Brereton	Hunter and Macleay	
... (part of)	Bathurst	Calcula Creek (partly).	Bray	Albert	Albert.
...	New England	Emmaville (partly).	Bringelleit (part of)	Bathurst	Calcula Creek.
...	Peel and Uralla	Tingha.	Broadmeadows	Clarence and Richmond	Boyd or Little River.
...	Hunter and Macleay		Brodies (& Tuenga)	Southern	Bogo (partly).
...	Albert	Albert.	Brunslab	Lachlan	Tyagong Creek.
...	Clarence and Richmond	Opara.	Buangla (part of)	Southern	Talwal.
...	Peel and Uralla		Bullengong (be	Tumut and Adelong	Molonglo (partly).
... (part of)	Tumut and Adelong	Molonglo (partly).	Bumbaldry	Lachlan	Tyagong Creek.
...	New England		Bundar	New England	Emmaville (partly).
...	Clarence and Richmond	Tweed and Richmond Rivers (part of).	Bundawarrah	Lachlan	Temora (partly).
...	Tamlaroora and Turon, and Mudgee.	Turon River (partly).	Do (part of)	do	do do
...	Peel and Uralla	Bingara (partly).	Burke	Southern	
... (part of)	do do	do do	Burra	Cobar	Began.
...	Bathurst	Oberon.	Burrendong	Tamlaroora and Turon.	Macquarie River, Stony Creek, Ironbarks, and Wellington.
...	New England	Bonnett and Lunatic.	Do (part of)	do do	Macquarie River, Stony Creek, and Ironbarks.
... (part of)	Albert	Albert.	Burrill	Lachlan	Began.
...	New England	Emmaville.	Byjerkerra	Albert	Albert.
...	Bathurst	Belmore (partly).	Byng	Bathurst	Byng (partly).
...	Southern	Drummalary.	Byngrass	Albert	Albert.
...	do		Cadger	Southern	Gulph (partly).
...	do		Calalat	Tumut and Adelong	Adelong Creek.
...	Hunter and Macleay	Barrington and Gloucester.	Callagyn (part of)	New England	Bonnett and Lunatic.
... (part of)	Peel and Uralla	Bingara.	Calcula (part of)	Albert	Albert.
...	do do	do	Canowindra	Bathurst	Canowindra (partly).
...	New England	Emmaville.	Carroll (part of)	Tamlaroora and Turon	Wellington.
...	Bathurst		Cargo	Lachlan	Cargo and Canowindra.
...	New England	Emmaville.	Do (part of)	do	Cargo.
...	Albert	Albert.	Castledon	Bathurst	Turon River and Kirkconnell
...	Peel and Uralla		Cataract (part of)	New England	Bonnett and Lunatic (partly).
... (part of)	Tamlaroora and Turon.	Macquarie River, Stony Creek, and Ironbarks	Cathcart	Albert	Albert.
...	do do	Wellington.	Cavendish	New England	Tinlaarra and Bonnett and Lunatic.
... (part of)	Albert	Albert.	Dennok	Hunter and Macleay	
...	Bathurst	Molgumnia and Abercrombie.			
...	Albert	Albert.			

MINING DISTRICTS—*continued.*

Parish, or part of.	Mining District.	Gold-field.	Parish, or part of.	Mining District.	Gold-field.
Challoner (part of)	Peel and Uralla	Upper Hunter (partly).	Giles (part of)	Albert	Albert.
Chandler do	New England	Bolaroo.	Gilgunery do	New England	Inverell and Lunatic.
Clare	Peel and Uralla	Hughes.	Gilmanton	Cobar	Drake.
Clarence (part of)	New England	Washpool Creek.	Gilmorton	Bathurst	Junction Point, Pauls Creek and Marchelan.
Clifford do	Tumut and Adelong	Limestone.			
Clifton	Bathurst	Ophir.	Glenken	Tumut and Adelong	Hanging Creek.
Clive	Peel and Uralla	Hughes.	Gnoopa	Southern	Pambula.
Coally (part of)	Albert	Albert.	Gobbagombalin	Hunter and Macleay	Gloucester.
Coast	Cobar	Drake.	Gordon	Peel and Uralla	
Cobb (part of)	Bathurst	Sofala and Turon (partly).	Gosamo (part of)	do do	Illawarra.
Colbert	Lachlan	Lachlan.	Gresley	Hunter and Macleay	Newcastle and Hunter.
Colleeno	New England	Inverell and Lunatic.	Gulgong	Macleay	Gulgong.
Coolah	Clarence and Richmond	Orara.	Gulph (part of)	Southern	Gulph (partly).
Coolie	Bathurst		Gunderang	Macleay	Gulgong.
Cookamidgera	Tamberoora and Turon	Macquarie River, Hunter Creek and Ironbarks.	Hall	Peel and Uralla	Kentucky Creek.
			Do	do	Ironbark and Tin Arse
Cookamidgera	Bathurst	Turon River.	Do	do	Bingara (partly).
Coradgerie	Albert	Albert.	Do (part of)	do	do
Corowa	Peel and Uralla	Gyra River.	Hanaffee	New England	Emmaville (partly).
Do (part of)	do do	do	Hampton	Bathurst	Sofala do
Cowrawaring	Hunter and Macleay		Hanging	Peel and Uralla	
Cope's Creek	Peel and Uralla	Tingha.	Hargraves	Macleay	Wellington.
Corella	Cobar	Bogan.	Hartley	Bathurst	
Cudgelly	Southern		Hasselick	New England	Emmaville.
Cunna	Albert	Albert.	Heathcote	Southern	
Cuny (part of)	New England	Inverell and Lunatic.	Herbert	Peel and Uralla	Tingha.
Cyvery	Peel and Uralla	Ironbarks and Oxley.	Herberton	Hunter and Macleay	Upper Hunter.
Dirk	Bathurst		Highland House	New England	Emmaville.
Dreadnought (part of)	New England	Emmaville.	Hughes	Albert	Albert.
Drayton	Hunter and Macleay	Gloucester.	Ironbarks (part of)	Tamberoora and Turon	Macquarie River, Stony Creek, Ironbarks, and Meadows.
Duke Bullen	Bathurst	Turon River (partly).			
Dulhunty	New England		Inverary	Southern	Nanninngs.
Dumaresq (part of)	Tamberoora and Turon	Wellington.	Inverell	Peel and Uralla	
Durangera do	do do	Macquarie River, Stony Creek and Ironbarks.	Jamberoo	Southern	
			Jamieson	Bathurst	
Durridgerie do	Lachlan	Billabong.	Jaques	Southern	
Durrandeen	Southern	Ophir (partly).	Jarrahdene	do	Bloodhound and Shumbany River (partly).
Dunedoo	Hunter and Macleay	Gloucester.			
Dubbo (part of)	Clarence and Richmond, Southern	Reed or Little River, Tyalwal.	Jingellic East	Tumut and Adelong	Ourama Creek.
Dungarra do			Jondra	Southern	
Durby	Peel and Uralla	Tingha.	Jooriya	Bathurst	Obley.
Dorrs Dorrs	do do	Bingara (partly).	Kalibah	Hunter and Macleay	
Do (part of)	do do	do do	Kangaloon	Southern	
Dowling	Albert	Albert.	Kelloomba	Bathurst	
Drum	do	do	Kembla	Southern	
Digby	Peel and Uralla		Kirk	Albert	Albert.
Donga	do do	Bingara.	Lake Macquarie	Hunter and Macleay	
Do (part of)	do do	do	Lane's End	New England	Emmaville.
Dumaresq	New England	Emmaville.	Langdale (part of)	Bathurst	Obley do
Dungowan	Peel and Uralla	Peel River.	Lannen	do	Ophir do
Dunlewy (part of)	Bathurst	Millburn Creek.	Lewis	Albert	Albert.
Edgar	Albert	Albert.	Do (part of)	Bathurst	Ophir (partly).
Ellerslie	Cobar	Bogan.	Lidsdale	do	Mount Lambie (partly).
Elsmore	Peel and Uralla	Tingha (partly).	Lister (part of)	Peel and Uralla	Swanbrook and Slatyvale (partly).
Emmett	Albert	Albert.			
Do	Peel and Uralla	Gyra River Extension.	Macintyre (part of)	do do	Bingara (partly)
Kekeldo	Bathurst	Clear Creek and Kirkconnell (partly).	Mabaratta	Albert	Albert.
			Maclashash (part of)	Lachlan	Bigenduon (partly).
Ettrema	Southern	Talwal.	Mandalong	Hunter and Macleay	
Euabera (part of)	Tumut and Adelong	Adelong Creek (partly).	Manildra	Lachlan	Obley.
Euroa	Peel and Uralla	Ironbarks and Tea-tree.	Maringarra	Bathurst	
Eusdale	Bathurst	Kirkconnell and Mount Lambie (partly).	Marsh (part of)	do	Ophir.
			Marsh	New England	
Fairy Hill	Albert	Albert.	Martin	Lachlan	Billabong.
Falnash	Bathurst	Turon River (partly).	Marulan	Southern	Argyle, Goulburn, and King.
Fitzroy	Cobar	Bogan.	Maryland	New England	
Flagstone	New England	Emmaville.	Mayo	Peel and Uralla	Tingha.
Forbes	Lachlan	Billabong and Lachlan, Wellington, Macquarie River.	Megalong	Bathurst	
			Merrigalah (part of)	Peel and Uralla	Gyra River.
Do (part of)	Bathurst	Stony Creek, Ironbarks, and Ophir.	Metz	do do	do
			Do (part of)	do do	do
Fowler's Gap do	Albert	Albert.	Mickimili	Cobar	Bogan.
Fremantle do	Bathurst	Ophir (partly).	Milroy (part of)	Albert	Albert.
Fraser	New England	Emmaville.	Mingelo do	Mudgee	Talmaglay.
Do	do		Mitchell	Peel and Uralla	
Gadara (part of)	Tumut and Adelong	Adelong Creek (partly).	Do (part of)	do do	Kentucky and Oxley.
Gairdner's Creek	Albert	Albert.	Molrey	do do	Bingara.
Galbraith	Bathurst	Newbridge and Caloola Creek (partly).	Montarlowe	Southern	Macquarie River (partly)
Do (part of)	do	Newbridge (partly).	Moonam (part of)	Peel and Uralla	Upper Hunter.
Gibraltar do	New England		Moorkaa	Albert	Albert.
			Moquillamba	Cobar	Bogan.

MINING DISTRICTS—*continued.*

Parish, or part of.	Mining District.	Gold-field.
.....	..uthern.....	Moruya (partly).
.....	Mudgee	
.....	Grant	
.....	Cotar	Bogan.
.....	Albert	Albert.
.....	Cotar	Bogan.
..... (part of)	Tumbarumba and Tumut	Maccumbe River, Stony Creek, Tumbarumba, and Murkaroo.
..... do	do do	do do
.....	Lachlan	Billabong.
.....	New England	Emmaville.
.....	Bathurst	Molgumma and Abercrombie (partly).
.....	Albert	Albert.
.....	Tumut and Adelong	Black Range (partly)
.....	Cotar	Bogan.
.....	Peel and Uralla	Bingara.
.....	Albert	Albert.
.....	do	do
.....	Southern	Argyle, Camden, and King.
.....	Bathurst	
.....	Southern	Gulph (partly).
.....	do	Nortumungah Creek.
.....	Peel and Uralla	Ironbark and Tea-tree (partly).
.....	Hunter and Macleay ...	Omara.
.....	Southern	Promontary.
..... (part of)	do	do
..... do	Albert	Albert.
.....	Clarence and Richmond	Boyd or Little River (partly)
..... (part of)	Peel and Uralla	Peel River (partly).
.....	Clarence and Richmond	Tweed and Richmond Rivers.
..... (part of)	Southern	Shoalhaven and Shoalhaven River.
.....	Bathurst	Oberon.
..... (part of)	Peel and Uralla	Upper Hunter.
.....	Hunter and Macleay ...	
.....	Peel and Uralla	Upper Hunter.
.....	Albert	Albert.
.....	Southern	Argyle, Camden, and King.
..., Mount	Albert	Albert.
.....	do	do
.....	do	do
North	New England	Emmaville.
.....	Lachlan	Billabong.
.....	Albert	Albert.
..... (part of)	Peel and Uralla	Upper Hunter.
.....	Albert	Albert.
..... (part of)	New England	Emmaville.
..... do	do do	Ironbark and Lunatic.
.....	Albert	Albert.
.....	New England	Emmaville.
..... (part of)	do do	do
..... do	do do	do
.....	Tumut and Adelong ...	Umaralla.
.....	New England	Ironbark and Lunatic (partly).
.....	Peel and Uralla	
..... of)	do do	Kookabookra.
..... do	do do	do
.....	Cotar	Bogan.
.....	Peel and Uralla and New England.	Emmaville (partly).
.....	Peel and Uralla	
.....	Tumut and Adelong ...	Belvedere, Jones, and Orangilly (partly)
.....	Albert	Albert.
art of)	Peel and Uralla	Kookabookra.
.....	Albert	Albert.
art of)	Peel and Uralla	
..... (pt. of)	New England	Emmaville (partly).
.....	Peel and Uralla	Tingha do
.....	Tamberoora and Tumut	Tumut River
part of)	Bathurst	Gully Swamp and Black Hills (partly).
.....	Cotar	Bogan.
.....	Albert	Albert.
.....	Southern	
..... dagai ...	Tumut and Adelong ...	Adelong Creek and Gundagai.
Springbrook	Clarence and Richmond	Boyd or Little River.
Stanford	Hunter and Macleay ...	
Stephen	Albert	Albert.
Stockington	Hunter and Macleay Extended.	
Stockton	Hunter and Macleay ...	
Do (town of) ...	do do	
Stonehenge	Peel and Uralla	
Stowell	Hunter and Macleay ...	
Strachan	New England	Emmaville (partly).
Strathleigh	do do and Peel and Uralla.	do do
Do North ..	New England	do do
Strathspey (part of).	do do	Ironbark and Lunatic.
Sutton	Hunter and Macleay ...	
Swinton	Peel and Uralla	Tingha.
Talbragar	Mudgee	Gulgong.
Tallaganda (part of)	Southern	
Tamberoora do ...	Tamberoora and Tumut.	Wellington.
Tara	Albert	Albert.
Tatarare	Hunter and Macleay ...	Drummuster (partly)
Tenandra	Mudgee	Mitchell's Creek.
Tenterfield	New England	Emmaville (partly).
Tera Hill	Hunter and Macleay	
Teralba	Bathurst	Mount Lambie.
Thornleigh	Peel and Uralla	Ironbark and Lunatic, and Timbarra.
Tingha	New England	
Tomago	Southern	Major (partly).
Tomaree	Hunter and Macleay ...	
Towgong	Lachlan	Carey and Carrowbulra (partly
Tops Tops	Hunter and Macleay ...	Gloucester.
Torrenrangee	Albert	Albert.
Torrens (part of) ...	Bathurst	King's Plains
Tost	Cotar	Bogan.
Trinbill (part of) ...	Tamberoora and Tumut	Wellington.
Trigalong	Lachlan	Tenpora.
Tuena	Bathurst	Abercrombie.
Tuggerah	Hunter and Macleay ...	
Tumbarumba	Tumut and Adelong	Timbarumba, Currant, and Burra Creek (partly).
Uarbrill (part of).	New England	Ironbark and Lunatic.
Ubobo do ...	Tumut and Adelong ...	
Umbarumberka ...	Albert	Albert.
Umarrah (part of).	Tamberoora and Tumut.	Wellington.
Umbidalla do ...	Southern	
Wabtia	Peel and Uralla	Swamp Oak and Mangata.
Wahah Wallah ...	Lachlan	Lachlan.
Wallendry	do	Grenfell(dry).
Wallers (part of)...	Tamberoora and Tumut.	Wellington.
Wangat	Hunter and Macleay ...	Gloucester.
Warrapamba	Bathurst	
Warrabra (part of)	Mudgee	Wellington.
Warre Warral ...	Tumut and Adelong ...	Belvedere, Jones, and Orangilly.
Waukaroo	Albert	Albert.
Wellington North ...	New England	Emmaville (partly).
Wellington Vale ...	do do	do do
Wells	Tamberoora and Tumut.	
Wertago	Albert	Albert.
West Fairfield	New England	Timbarra.
Willie Bloma	Tumut and Adelong ...	Adelong Creek.
Wiljanna, (village of)	Albert	Albert.
Wolleyer (part of)...	Mudgee	Wellington.
Wallonia	Southern	
Wongawilli	do	Albert.
Wood's Reef	Peel and Uralla	Iron-bark and Tea-tree.
Woman	Albert	Albert.
Worcester	Bathurst	Ophir
Worra	Peel and Uralla	Kookabookra.
Wyadra	Mudgee	Gulgong.
Wyalong	Southern	
Wylie	New England	Ironbark and Lunatic (partly)
Yalwal (part of) ...	Southern	Yalwal.
Yarrowlumla	Albert	Albert.
Do North ..	do	do
Yarralaw	Southern	Argyle, Camden, and King
Young (part of) ...	Lachlan	Burrangong.
Yowaka	Southern	Pambula
Do (part of) ..	do	do

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